POWER

Established 1884—McGraw-Hill Publishing Company, Inc.

ELY C. HUTCHINSON, *Editor*

VOLUME 75 MARCH 1, 1932 NUMBER 9

Autocratic Specifications

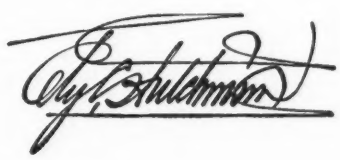
One of the most pestiferous enemies to amicable trade relations between buyer and seller is the supertechnical, semi-legal specification. Any manufacturer bidding on government specifications knows, for instance, how completely he must place himself in the hands of the purchaser and what it sometimes costs to do so.

But outside of government business, where the purchaser reserves the privilege of not accepting the lowest bid and it is possible to select the type of seller with whom to do business, the autocratic form of specification is unnecessary and unwise.

For the purchaser to assume plenary powers such as to say that he shall be both judge and jury on arguable points, or that "this" or "that" shall be done to the "satisfaction" of the engineer, meaning himself, is almost certain to cause trouble or cost money.

Honorable sellers with years of background and pride in their engineering and manufacturing reputations do not relish the feeling that there is no recourse where arbitrary interpretation of a specification clause or a set idea of the purchaser's may cause complications and add heavily to their expense. Don't forget that sellers know an over-meticulous specification generally means bickerings and uncertainty as to the ultimate cost of the job. So they fix the bid price accordingly.

The simple specification that indicates what is to be done, the grade of equipment and results desired, and thereafter leaves room for real cooperation between buyer and seller, will always win in price and accomplishment.



EDITORIALS

A Bill That Deserves Support

A bill (HR6187) before Congress, that is of particular interest to engineers, directs the Secretary of the Treasury to contract for outside architectural and engineering services in the designing and planning of public buildings. This work now centers in the Government Architect's office which is overloaded while consulting engineers and architects all over the country are idle.

Aside from the desirability of distributing this work and thus aiding the profession in this time of stress, it is conceivable that many of the new buildings in various localities present problems in power supply and building services that warrant the sort of study and analysis such as the overworked and inadequately manned Government office is unable to give. Local firms familiar with local conditions should be better fitted to render expert opinion.

The purpose of the bill has been stated as an effort to take the Government out of business as a competitor of private concerns, but this more or less controversial point warrants small consideration in the present emergency. The important thing now is to extend legitimate aid to the profession and to secure the most competent engineering services in connection with the new building program.

The bill should be supported by all engineers and is worth a letter or telegram to your Congressman.

Modernizing Elevator Service

Modernizing is now recognized as the watchword of every industry. An industrial plant in which the machinery and manufacturing processes do not take advantage of improvements is at a serious disadvantage with those where modern methods are employed. Failure to modernize has caused many industrial establishments to give way to more progressive ones and to finally close up shop.

Principles that apply to the modernizing of industrial processes hold equally true for office and other types of public buildings. If the services in buildings are allowed to become antiquated it becomes more difficult to keep them occupied and to maintain them on a paying basis. Tenants come more closely in contact with the elevator than any other service. If the elevators are antiquated the age of the building is impressed upon every one. Elevators in modern buildings are so vastly improved over those installed in the older types of structures that the shortcomings of the latter are greatly magnified.

By modernizing the elevators in older buildings, they will be more rentable and the cost of rendering the service, per tenant, reduced. Modern elevators not only make a building more desirable for the old tenants to remain in, but they are an incentive for new ones to come. The cost of operation, including power and maintenance, of many old elevators is out of proportion to the service they render. Furthermore, new elevators will provide a service superior to the old ones. No time is more opportune than this period of low costs to modernize elevators and other antiquated equipment in buildings.

Evaluation of Manufacturer's Proposal

It is quite frequent practice among engineers to evaluate the proposals of manufacturers for furnishing major power plant equipment, and to place preferences on the various bids as determined by the evaluation. The cheapest combination, all things considered, is then purchased.

An important part of the evaluation considers the performance guarantees. The saving due to superior efficiency of one equipment over another is calculated for its expected life and the present worth of the savings forms a part of the preference.

When bids are considered on this basis they should be accompanied by penalty and bonus clauses to assure the purchaser that the performance guarantees are bonafide and to protect reputable manufacturers. The basis of the penalty and bonus clauses should be made a part of the specifications so that all manufacturers' bids will be comparable.

Equipment purchased under such agreements must be tested after installation to find out whether bonus or penalty is to be paid. Before entering into a penalty and bonus contract the purchaser should determine whether the necessary tests can be performed with the accuracy required for a fair decision and must be willing to pay their cost.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

▼

A two-cylinder tandem-compound reaction turbine of 115,000-kw. capacity drives single 18,000-volt generator. Steam conditions are 650 lb. and 750 deg. F. Standard and reheat boilers of horizontal single-pass type are equipped with tube mills, steaming economizers, tubular air heaters and slag-tap furnaces from which the slag is sluiced to the premises. Rotary car dumper and mule-haul feature the coal handling

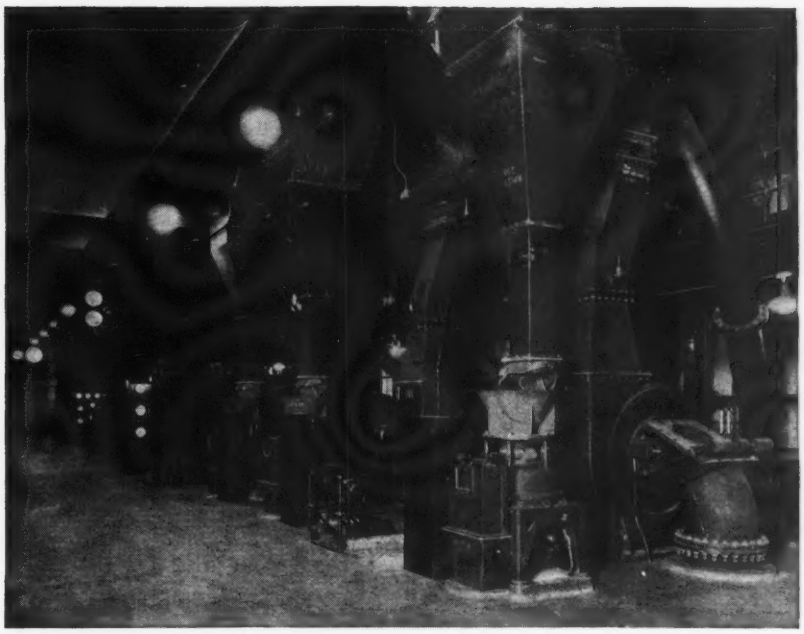


Fig. 1—Operating floor, on which are located feeders, mill exhausters and boiler control panels

Latest Unit Addition to Waukegan Station Has Many Interesting Features

WAUKEGAN station of the Public Service Company of Northern Illinois has had its capacity augmented to 290,000 kw. by the placing in operation recently of unit No. 5, a turbine-generator of 115,000 kw. capacity at 95 per cent power factor. The unit with its complement of boilers has a number of features out of the ordinary. The turbine is of the two-cylinder tandem-compound reaction type with a double-flow low-pressure cylinder. Temperature and pressure conditions at the throttle are 650 lb. and 750 deg. F. Steam is withdrawn from the high-pressure cylinder at about 200 lb. pressure and after being reheated to the initial temperature is returned to the low-pressure cylinder. The general design of the unit is similar to that of the 65,000-kw. machine installed in 1930 except that the generator voltage is 18,000 instead of 12,000. The generator rotor is said to be the largest forging ever made in this country, weighing 135 tons before machining. Excitation is provided by a direct-connected exciter and a pilot exciter. Generator air cooling is effected by a fin-type cooler placed between the generator and the fans, which are four in number, with a total capacity of 200,000 cu.ft. per minute. Either condensate or circulating water may be used as the cooling medium.

In the condenser, 80,000 sq.ft. of surface has been provided in tubes of $\frac{7}{8}$ in. diameter. Circulation water is supplied by two vertical-shaft centrifugal pumps having discharge openings 60 in. in diameter. They are driven by 385-hp. two-speed induction motors. At the high speed of 166 r.p.m. the two pumps have a combined capacity of 132,000 gal. per minute.

Boiler equipment serving the new machine consists of two standard and one reheat boiler, each fired by three unit mills. The boilers are of the horizontal single-pass type equipped with tubular air heaters designed to furnish air at approximately 440 deg. F. at normal rating on the boilers, steaming-type economizers, and complete water-cooled furnace walls and bottoms. The table gives the surface in boilers and auxiliaries:

HEATING SURFACE IN BOILERS AND AUXILIARIES, SQ. FT.

	Standard	Reheat
Boiler heating surface	9,967	8,565
Economizer	28,600	6,860
Air heater	64,088	64,088
Reheater	.....	32,400
Furnace walls	3,810	3,810

Output from the standard boilers ranges from a nor-

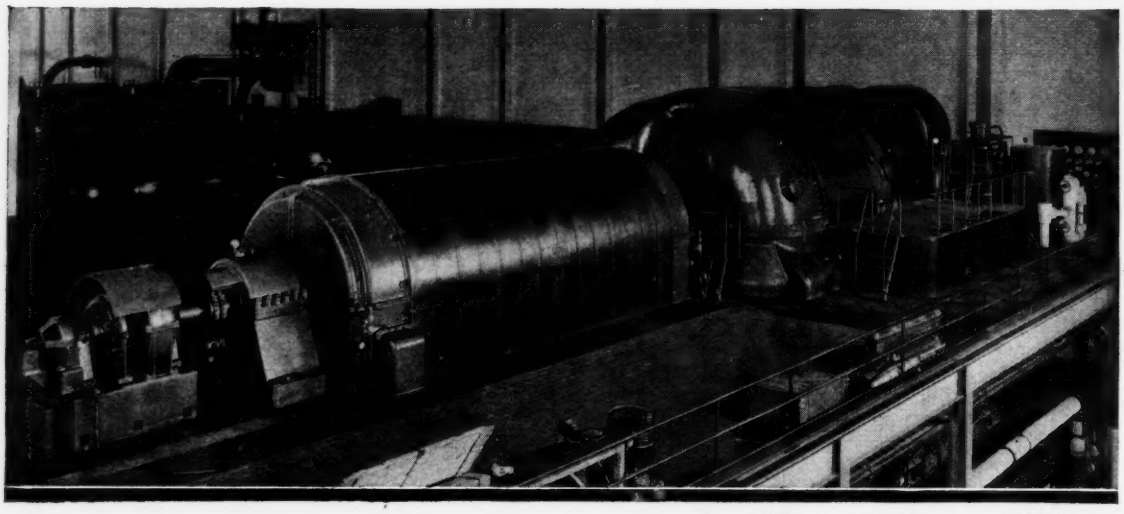


Fig. 2—Unit No. 5, a 115,000-kw. Allis-Chalmers tandem-compound turbine driving an 18,000-volt generator

mat of 365,000 lb. of steam per hour to a maximum output of 495,000 lb. In the reheat boiler the reheat section is designed for a maximum of 930,000 lb. of steam per hour, while the live-steam section has a normal evaporating capacity of 265,000 lb. and a maximum of 300,000 lb. of steam per hour.

Each boiler is served by two forced-draft fans driven by a single variable-speed induction motor, the capacity of each fan at 1,160 r.p.m. approximating 300,000 lb. of air per hour. There is one induced-draft fan per boiler, and each fan is driven by two motors, a variable-speed induction motor to provide a range up to 514 r.p.m. for normal operation and a 695-r.p.m. constant-speed induction motor for maximum conditions. At the maximum speed and a gas temperature of 365 deg. F. each fan will handle 695,000 lb. of gas per hour. Specially designed to reduce erosion, the fan rotors are 99 in. in diameter with shafts having a maximum diameter of 16 inches.

There are three 48-in. tube mills per boiler, each of which has a maximum rating of 14 tons of pulverized coal per hour through two cross-tube burners which produce a short horizontal, highly turbulent flame. With disk feeders, variation in coal feed is obtained by the use of brush-shifting motors controlled from the boiler operating panel. The mills are driven by 300-hp. motors and the mill exhausters by 75-hp. motors, both of the constant-speed type.

Furnace bottoms are of the water-tube type, covered with cast-iron blocks, designed to prevent growth and the consequent pushing out of furnace walls. The slag is drawn off from two taps and conveyed in granulated form by water jets to a small pit in the basement, from which two vertical pumps discharge it to a low portion of the property for filling.

Automatic combustion control of the oil-operated type is installed, not only to maintain the desired fuel-air ratio, but also, through a master control panel, to maintain the proper steam pressure. On the reheat boiler the control is arranged to vary the heat input to the furnace, so that a constant temperature is maintained on the reheater outlet regardless of the quantity of steam flowing through the reheat section of the boiler.

Steam is bled from four points in the turbine casing to raise the temperature of the feed water at full load rating from 92 to 380 deg. F. Absolute pressures at the four bleed points are: 5, 18, 66 and 213 lb. Make-up is supplied from a double-effect evaporator with a capacity of 40,000 lb. of water per hour.

Five boiler-feed pumps, each with a capacity of 800 g.p.m. against a discharge pressure of 900 lb., have been provided. Four are electrically driven by 650-hp. motors and the fifth by a 620-hp. steam turbine.

To minimize the size of valves and fittings, a double header system has been arranged. On each standard boiler the superheater has an outlet on each side of the boiler to each header. Electrically operated relief valves are installed on both main headers and on the line from the turbine to the reheater.

To care for the increased coal consumption of the station, the conveyor system has been speeded up to 400 tons per hour and an additional breaker and secondary crusher installed, as well as a rotary car dumper and a mule-haul. As the latter equipment is the first to use all alternating-current motors and control, the installation is of special interest and will be covered in a subsequent article.

The electrical layout for unit No. 5 is quite different from preceding installations in this plant. There is no 18,000-volt bus and no generator oil circuit breakers are provided, for the generator and transformers are considered an operating unit, and oil circuit breakers are provided only on the 132,000-volt side of the 120,000-kva. transformer bank. The 10,000-kva., 18,000 to 2,400-volt auxiliary transformer is connected directly to the generator leads. The oil circuit breakers on each side of this transformer bank prevent trouble in the auxiliary transformer from causing a shut down of the unit.

Generator protection is obtained by the use of differential relays which trip the generator field switch, the 132,000-volt transformer switchgear and the auxiliary transformer switchgear unit. The instrument transformers used to operate the generator protective relays are installed in a metal-clad compartment located on one side of the generator foundation.

Transformers on the 120,000-kva. bank have a number of interesting features. They are designed for cable connections on both the high- and low-voltage sides, which are placed in special bolted compartments on the sides of the transformer. The connections can be unbolted, leaving the cable installations undisturbed in case it is

necessary to move a transformer. On the 18,000-volt side the transformers are delta connected, the connection being made by means of cable at the transformers. Since the generator and transformers will operate as a unit, no tap changing mechanism under load has been provided, because voltage variations may be obtained by changing the excitation of the generator. The transformers are provided with fans which start automatically when the load reaches two-thirds of the rated capacity of the transformer. Each transformer weighs about 222,000 lb. and contains about 11,000 gal. of oil in the main tank.

The 132-kv. metal clad switchgear consists of two double bus positions having a current-carrying capacity of 1,200 amp. The buses are made of 3,020,000 c.m. 132-kv. oil-filled cable weighing about 28 lb. to the foot. This oil is treated until it contatins less than 1 per cent of air, which offers a marked contrast to ordinary oil having a gas content of about 16 per cent.

Disconnecting switch units travel vertically on motor-driven jack screws. They can be operated in groups or individually when desired for test purposes. These units are designed so that it is possible to check the position of the disconnecting switch through a sight glass provided to prevent operating errors, oversights or omiscertain that there is no connection to the 132-kv. bus.

Mechanical, magnetic and electrical interlocks are provided to prevent operating errors, oversights or ommissions which might damage the equipment or injure the operating personnel. On the disconnecting switches, for instance, interlocks prevent opening any or all disconnecting switches on both sides of an oil circuit breaker when it is closed; they prevent closing an oil circuit breaker unless all of the associated disconnecting switches on both sides of the oil circuit breaker are all the way open or closed; they also prevent closing any disconnecting switch to the bus when any bus test switch is closed to the same phase; and they prevent operating any test switches until the corresponding disconnecting switches are open.

Like the single-phase 40,000-kva. transformers, the 10,000-kva. 3-phase auxiliary transformer is designed for cable connections on both high- and low-voltage sides. The transformer connects to the generator leads on the 18,000-volt side and to the main auxiliary 2,400-volt bus on the low-voltage side. Differential protection is provided so that any trouble in the auxiliary transformer will not affect the operation of the unit. Automatic tap changing under load equipment has been provided on the 18,000-volt side of the transformer to compensate for voltage changes in the generator, thus keeping the voltage on the low-tension side constant. This is important, for the section of the main auxiliary bus for unit No. 5 may be connected to the main auxiliary bus provided for Units 3 and 4 and reactors have been installed between these sections to limit short-circuit currents.

Three buses have been provided for the auxiliary equipment switchgear. The main 2,400-volt bus in the turbine room basement is used to control the power supply for the circulating water pumps, the condensate pumps, the boiler-feed pumps, the generator air fans, etc. Switchgear units in this bus are used, in addition, to feed the switchgear located in the boiler room, and units in this bus are used also to supply sub-auxiliary 2,400- to 460-volt transformers which feed the sub-auxiliary bus. The carrying capacity of these switchgear units ranges from 3,000 amp. for the auxiliary transformer switch down to 400 amp.

To eliminate operating hazards in the pulverized-coal system an elaborate control system has been arranged to secure by means of interlocks prescribed operating procedure which cannot be deviated from. The prescribed operating routine is that the induced-draft fan must be running under all conditions when a boiler is in service, to prevent the building up of a positive pressure in the furnace and the possibility of blowing flame into one of the mills, thus causing an explosion. After the induced-draft fan is running, the forced-draft fan may be started, and so on down the line in order for the exhauster, pulverizing mill and pulverizing mill coal feeder.

As the draft fans form the heart of the interlock system, the method of starting and stopping under normal and emergency conditions is of interest. Two different

Fig. 3—The three boilers of the new unit are served by nine 14-ton mills with constant-speed motor drive through herringbone gears

motors are used at opposite ends of the induced-draft fan shaft to provide operating flexibility. The slow-speed 325-hp. wound-rotor motor is started by closing its power supply oil circuit breaker. If this low-speed motor is running at its maximum speed, and more air is required, the motor controller notches up one more step to a limit switch which causes transfer relays to close the circuit breaker of the high-speed 900-hp. squirrel cage motor. Under normal conditions the high-speed induced-draft fan motor is taken out of service by tripping the high-speed motor oil circuit breaker by means of its control switch.

Arrangements also have been made so that when the high-speed motor oil circuit breaker is tripped and the motor speed drops to about 520 r.p.m. a centrifugal switch geared to the fan and motor shaft operates and completes the closing circuit for the low-speed oil circuit breaker, thus placing the low-speed fan motor in service. In case of a failure of the high-speed or low-speed motor, causing the speed of the fan and motor shaft to drop to about 230 r.p.m., another centrifugal switch geared to the shaft operates and completes the tripping circuits of the oil circuit breakers on all of the boiler auxiliaries, thus shutting down the boiler.

After the induced-draft fan motor is running, the forced-draft fan power supply oil circuit breaker can be closed. Normally, the forced-draft fan is taken out of service by tripping its power supply oil circuit breaker. Under emergency conditions, however, the forced-draft fan and all of the other equipment below it in the sequence may be taken out of service by failure of both induced-draft fan motors, which causes the centrifugal switch to operate, thus completing the tripping circuits for all subsequent equipment; by trouble in the forced-draft fan motor circuit which causes the oil circuit breaker to operate automatically; by operation of a centrifugal switch on its shaft after the speed drops below about 500 r.p.m., thus completing the tripping circuits for all the equipment following it in the sequence.

Exhausters, mill and coal feeders are started by closing their power supply oil circuit breakers or magnetic contactor after the preceding piece of equipment in the sequence is running. Each of these pieces of equipment, however, has some special stopping features. The exhauster, mills and coal feeders, of course, would be taken out of service by failure of the induced-draft or forced-draft motors. Normally the exhausters, mills and coal fan feeders would be stopped by means of their oil circuit breaker control switches. The mills may be stopped by emergency push buttons located near them in case the operator notices an over-supply of coal or "plugging." When the pulverizing mills contain an excessive amount of coal, a mercoid switch operates, shutting off the power supply to the coal feeder motor. If the coal feeder motor is overloaded, thermal relays cause the magnetic contactor to operate, thus taking the motor out of service.

The foregoing system has been in use to control seven pulverizing mills for approximately a year and a half on unit No. 4, where the scheme was thoroughly tried out, and the same system has been in use on unit No. 5 to control nine mills since the first of September, 1931. The operating record has been satisfactory, for there have been no "puffs," "flash-backs" or injuries to property or personnel.

Use of alternating-current brush-shifting motors to secure the speed variation necessary to supply coal in response to the demands of the automatic combustion control system is a rather interesting application. The automatic combustion control equipment closes a contactor through a complex mechanical system which starts the brush-shifting pilot motor on the BTA motor when a speed change is required. In this way an infinite number of speeds may be obtained.

Another rather unusual use of alternating-current motor is to operate the car mule provided to push coal cars up the 15-deg. incline to the rotary car dumper. A two-speed 440-volt, 3-phase torque motor and a slip-ring 500-hp. 2,300-volt three-phase motors are connected to a common shaft. This shaft is connected to the mule hoisting and lowering drum through herringbone gearing. By the use of contactors for accelerating and reversing the motors, of small contactors actuated by time closing relays, of general type limit switches, of the torque motor to take the slack out of the hoisting cable and of a spring bumper to absorb the car mule engaging impact, an alternating-current installation has been designed that provides sufficient operating flexibility for all practical purposes.

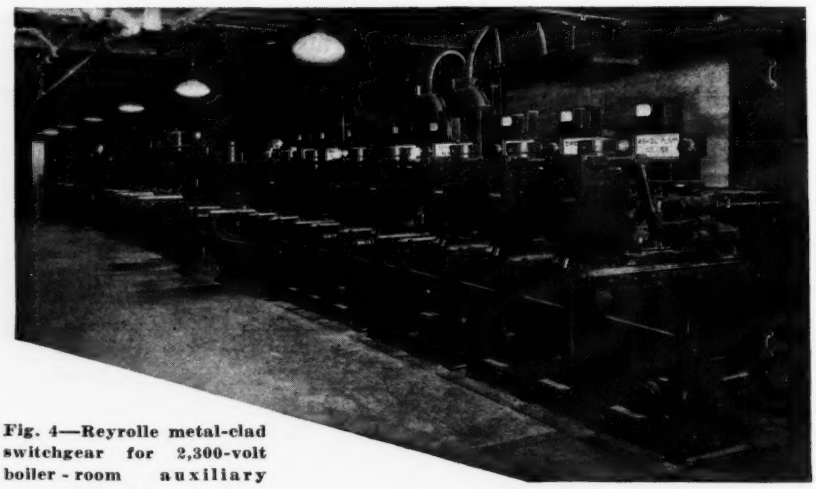


Fig. 4—Reyrolle metal-clad switchgear for 2,300-volt boiler-room auxiliary motors

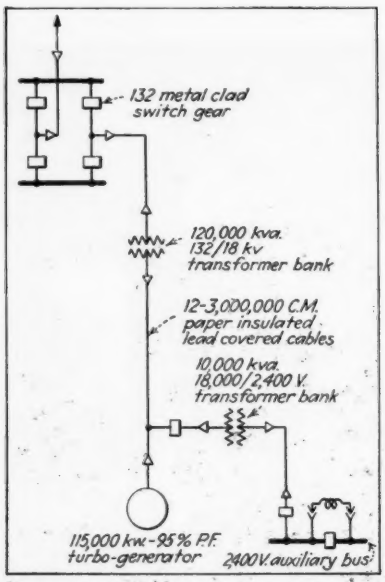

132 metal clad switch gear
120,000 kva. 132/18 kv transformer bank
12-3,000,000 C.M. paper insulated lead covered cables
10,000 kva. 18,000/2,400 V. transformer bank
115,000 kw-95% P.F. turbo-generator
2400 V. auxiliary bus

Fig. 5—Diagram of electrical connections to unit No. 5

The Fundamentals of Boiler Blowdown

By W. J. RYAN
Mechanical Engineer
New York City

Mr. Ryan shows by simple examples how to compute blowdown ratios. He also discusses several systems of continuous blowdown

EVERY boiler feedwater contains at least a small amount of dissolved mineral salts and other solids, and this is true even if the make-up water has been evaporated. However in plants where evaporators are used, the blowing down of the boilers usually does not present any problem.

In a plant where "raw" or softened water is used for make-up, the blowing down of the boilers may be a source of trouble and annoyance or may constitute a serious problem. As water is continually being fed and steam is continually passing off, the amount of dissolved solids in the boiler water (water *in* the boiler) tends to increase continually. These salts may be in solution or suspension, or may be deposited as scale or sludge.

If the concentration of salts becomes too great, foaming or priming may result; or even without foaming, a large quantity of troublesome salts may be carried over with the steam. For instance, if the concentration of the boiler water is 5,000 p.p.m. (parts per million) total dissolved solids, and there is 1 per cent moisture in the steam, 1,000,000 lb. of steam will carry 50 lb. of solids. In the absence of oil or excessive amounts of organic matter, the tendency toward foaming, generally speaking, increases with the density of the boiler water.

Calculating Blowoff Required

If a feed water be completely softened, as for instance by means of a zeolite softener, it will have commercially zero hardness, that is practically no scale-forming salts. It will contain only such salts as will remain in solution in the boiler and not precipitate as scale or sludge. Under these conditions it is possible to calculate theoretically the amount of blowdown required. Leaving out of consideration the small amount of boiler water carried off by the steam, it is apparent that all the salts introduced into the boiler in the feed water must eventually find their way out through the blowdown.

This can be expressed by an equation as follows:

$$\left(\begin{matrix}\text{gallons of}\\ \text{blowdown}\end{matrix}\right) \times \left(\begin{matrix}\text{dissolved salts per}\\ \text{gal. of blowdown}\end{matrix}\right) = \left(\begin{matrix}\text{gallons of}\\ \text{feed water}\end{matrix}\right) \times \left(\begin{matrix}\text{dissolved salts per}\\ \text{gal. of feed water}\end{matrix}\right)$$

From the above it follows that

$$\left(\begin{matrix}\text{gallons of}\\ \text{blow-off}\end{matrix}\right) = \left(\begin{matrix}\text{gallons of}\\ \text{feedwater}\end{matrix}\right) \times \left(\frac{\begin{matrix}\text{dissolved salts per gal. of feedwater}\end{matrix}}{\begin{matrix}\text{dissolved salts per gal. of blowdown}\end{matrix}}\right)$$

From this formula, the amount of blowdown can be calculated if the amount of dissolved solids in the feedwater is known, and if a certain figure is decided on for the concentration to be maintained in the boiler. For instance, if the feedwater contains 5 gr. (grains) of dissolved solids per gallon, and it is desired to maintain the concentration of the boiler water at 200 gr. per gallon, the blowdown will be

$$\frac{5}{200} \times 100 = 2.5 \text{ per cent of the feedwater}$$

Hardness Changes Computation

If the feedwater contains any hardness the situation is somewhat different. Suppose the water contains 5 gr. per gallon total dissolved solids, of which 3 gr. are soluble sodium salts and 2 gr. are calcium salts. If all the calcium salts are deposited as scale or sludge the blow-off required to hold the concentration at 200 gr. per gallon *in solution* will be

$$\frac{3}{200} \times 100 = 1.5 \text{ per cent of the feedwater}$$

If 1 gr. of the calcium salts precipitates and is deposited as scale or sludge, and 1 gr. precipitates but

remains in suspension, a blow-off of 1.5 per cent will result in a concentration of suspended matter equal to

$$\frac{1\text{ gr.}}{0.015} = 66\text{ gr. per gallon}$$

If we were to assume that all the calcium salts remain in suspension, the total concentration of suspended matter would reach 132 gr. per gallon and the total of dissolved and suspended matter would be 200 + 132 = 332 gr. per gallon. To keep this total down to 200 gr. it would be necessary to blow down the same amount as in the case of the completely softened water, namely

$$\frac{5}{200} \times 100 = 2.5\text{ per cent of the feedwater}$$

If a hard water be used for boiler feed without any treatment, either external or internal, the required blow-

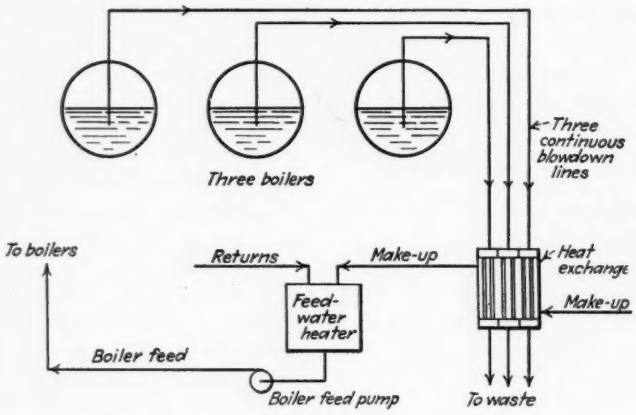


Fig. 1—Continuous blowdown with multi-stream heat exchanger

down will usually be less than if that water were softened. The blowdown water will have a relatively low density and the salts in the feedwater will largely deposit as scale or sludge, which are removed at intervals by mechanical cleaning methods.

Uniform Concentration Not Necessary

Considerable emphasis is sometimes put on the desirability of maintaining an unvarying concentration in the boiler water and it is sometimes stated that with continuous blowdown the concentration can be held at a constant figure, whereas with intermittent blow-off there will be very wide fluctuations in the concentration. Such is not the case, and anyhow the important point is to keep the concentration below a certain point rather than to try to keep it at a constant figure. The act of blowing down does result in certain fluctuations in the concentration, but the extent of such fluctuations is small with a modern boiler.

For instance a typical 5,000-sq.ft. cross-drum boiler contains 35,000 lb. of water, of which 5,200 lb., or 15 per cent, is in the drum. If the drum has a diameter of 40 in., a blowdown of 6 in. of water in the gage glass will only amount to about 6 per cent of the contents of the boiler. Therefore if this amount of water be blown down, and the boiler filled up to the normal level with fresh feed water, the concentration will be reduced about 6 per cent.

It is theoretically possible to operate a boiler with intermittent blowdown and keep a constant concentration in the boiler water, that is, if the load is constant. It could be done by feeding water at a slightly greater rate than the rate of evaporation, and blowing down the excess water at any convenient time or whenever the level rose too high in the gage glass.

Continuous blowdown will eliminate the more or less regular up and down fluctuation of boiler-water density that would result from intermittent blowing down, but will not eliminate the variations due to change of load or change in quality of feed water. To do this it would be necessary to regulate the continuous blowdown automatically in proportion to the impurities entering the boiler, taking into account changes of load, changes in the relative amounts of make-up and returns and changes in the quality of the water. However, the important thing is to keep the concentration below a certain maximum limit. As will be explained later it is easier and more economical to do this by continuous rather than by intermittent blowdown.

Blowdown in Terms of Make-Up

In the foregoing discussion it is shown that the blowdown can be calculated as a certain percentage of the feed water, but as a matter of fact it is usually calculated as a certain percentage of the make-up, because the return condensate can usually be assumed to be pure or only slightly contaminated as compared to the make-up. The formula for the required blowdown to maintain a certain concentration in the boiler water will then be:

$$\textit{Blow-down} = (\textit{make-up}) \times \left(\frac{\textit{Total solids in make-up}}{\textit{Concentration to be maintained in boiler}} \right)$$

Whether the blowdown is expressed as a percentage of the feedwater or as a percentage of the make-up, it is important to note that it is a certain percentage of the water actually fed to the boiler. Therefore in selecting the size of water treating plants, feedwater heaters, etc., the total water must be considered. This will include the amount to be evaporated for the required steam, plus the blowdown.

For instance, suppose that a new plant is to be built and it is estimated that the amount of steam required is 100,000 lb. per hour (no returns). The only feedwater available is such that no practicable treatment will reduce the dissolved solids below 300 p.p.m. It is desired to limit the concentration in the boiler water to 3,000 p.p.m. The required amount of blowdown can be determined by the following formula, in which the water actually *fed* to the boilers is (100,000 + blow-off)

$$(100{,}000 + \textit{blow-off}) \times (300\text{ p.p.m.}) = (\textit{blow-off}) \times (3{,}000\text{ p.p.m.})$$

$$\textit{Blow-off} = \frac{30{,}000{,}000}{3{,}000 - 300} = 11{,}111\text{ lb. per hr.}$$

So the water to be fed to the boilers is 111,111 lb. per hour, of which 100,000 lb. will be evaporated and 11,111 lb. will be blown off.

Systems of Continuous Blowdown

In plants where the required amount of blowdown is large in relation to the water holding capacity of the boiler, very frequent blowing down may be required. In such plants it is more convenient and economical to blow down continuously rather than to blow down large quantities intermittently, since by means of continuous blowdown the heat in the blowdown water usually can be recovered. There are several different systems of continuous blowdown in use. The question of which is best for a given plant depends largely on three considerations: namely, whether or not it is necessary to control

the concentration within close limits; how the heat can best be recovered from the blowdown water; and the cost of the blowdown installation, including the necessary piping, heat exchangers, etc.

Fig. 1 shows an arrangement that has been used in a number of installations. While the diagram shows three boilers, the same arrangement is applicable to a larger number. From the steam drum, or one of the steam drums, of each boiler, a small continuous blowdown line is run to a heat exchanger. This is designed for several separate streams of blowdown water, thus allowing separate and accurate control of the flow from each boiler. In this diagram the make-up water is used to cool the blowdown water, which is advantageous where there is not an adequate supply of exhaust steam for heating the feedwater. Further information regarding the construction of the heat exchangers is given later.

Fig. 2 shows another arrangement that is used frequently. In this case the several streams of blowdown water are joined before entering the heat exchanger. It is better to control the blowdown at point marked *A* on the diagram rather than throttle the individual streams at point *B*. If the streams were throttled at *B* there might be flashing at this point, with consequent water hammer and erosion in the heat exchanger. Valves can be located at *B* to balance the flow between the several boilers. The single-stream heat exchanger is cheaper than the multi-stream heat exchanger for the same total quantity of blowdown.

Heat Exchange at Higher Temperatures

Fig. 3 shows a hook-up with two single-stream heat exchangers in series. The one that is marked "high pressure heat exchanger" is located on the boiler feed line between the feed pump and the boilers. The blowdown water passes through this heat exchanger first, and is cooled to near the temperature of the feedwater. It then passes through the "low pressure heat exchanger" where it is further cooled by the make-up.

This hook-up can be used to advantage in plants where there is a slight deficiency of exhaust steam for heating the feedwater, but where the heat in the blowdown cannot all be transferred to the makeup, but some must be absorbed by the feed water

This arrangement could be modified by using multi-stream heat exchangers such as shown in Fig. 1, in which case each stream of blowdown would be kept separate.

Fig. 4 shows a continuous blowdown arrangement based on a different principle, namely the use of a flash tank. The pressure drop in the blowdown water entering the flash tank causes a portion of it to evaporate into steam which passes to the heater or to the exhaust-steam header. The non-flashed blowdown water is drained from the tank through a heat exchanger where it is cooled by means of the make-up water.

This arrangement is similar in effect to that shown in Fig. 1, in that all the heat in the blowdown is utilized in the open heater, and therefore no saving would be effected in a plant where adequate exhaust steam is available.

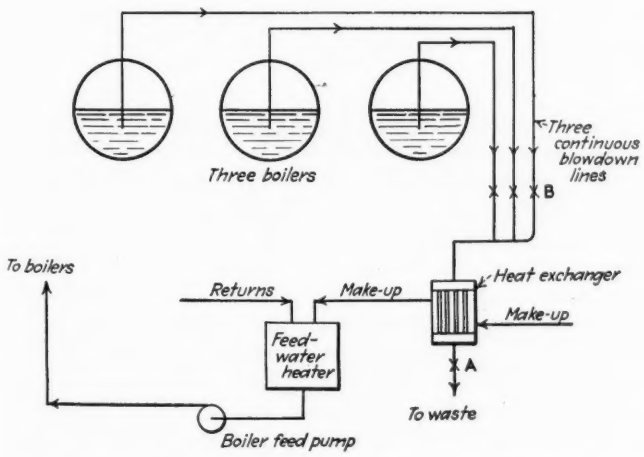


Fig. 2—Same as Fig. 1 but with single-stream heat exchanger

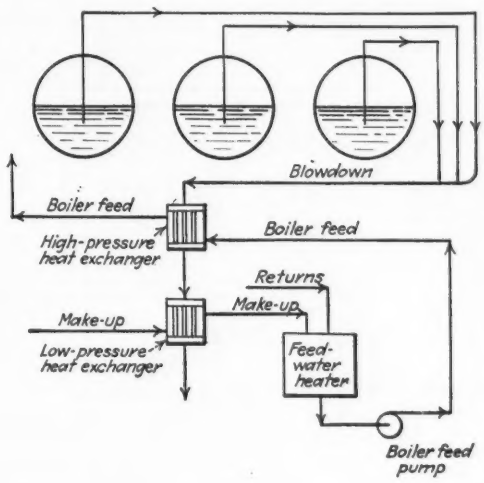


Fig. 3—System with "high-pressure" and "low-pressure" heat exchangers

Modified Flash-Tank Arrangement

A modification of the flash tank arrangement is to use two flash tanks in series. In a plant where steam at two different pressures is used, say 100 lb. and 300 lb., the blowdown water under 300 lb. pressure would flow into a flash tank in which the pressure of 100 lb. is maintained by connecting the steam outlet of the tank to the 100-lb. main. The flashed steam from this tank would go to the 100-lb. main and the non-flashed blow-off water would flow through a heat exchanger located on the boiler feed line. It would then flow to a low-pressure flash tank located in the same way as the one shown in Fig. 4. In this way a part of the heat is recovered to the feed water and part to the make-up water and therefore a direct saving of heat is accomplished even if plenty of exhaust steam is available.

There are other ways in which the heat in the blowdown water can be utilized, such as passing the blow-off through a heat exchanger located on the raw water line to a hot process lime and soda ash softener. In plants where the heat balance is such that there is no way of recovering the heat from the blow-off water, it may still be desirable to use continuous blow-off for its convenience. In fact, under certain conditions, it may be impossible to discharge the required amount of water through the operation of the regular blowdown valves.

Design of Heat Exchanger

The heat exchanger for continuous blowdown service can be made according to any of the conventional designs, such as the U-tube construction or the floating head construction. Except for very small units, it is not

advisable to use straight tubes with fixed tube sheets, because of the expansion strains that would result from the wide temperature changes involved during operating fluctuations.

Each of the designs mentioned above, namely the floating head and the U-tube, has certain advantages. With the floating head it is easier to put a cleaner through the tubes and it is usually easier to replace a tube. With the U-tube construction each tube is free to expand and contract independently of the others, thus eliminating the expansion strains that might occur in the bundle of other signs. Generally speaking, the

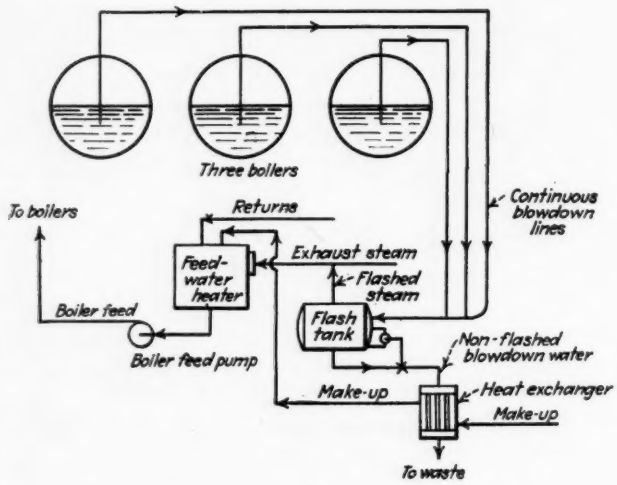


Fig. 4—Blowdown system with flash tank

U-tube construction is likely to be cheaper for a multi-stream exchanger on account of eliminating the floating head with the partitions and reinforcing staybolts that may be required to prevent leakage from one stream into another.

For tube material copper is best. Owing to the increasing tendency toward using treated feedwater, the boiler water will probably contain a certain amount of caustic soda. If the tubes are made of an alloy containing zinc there will be a tendency toward dezincification caused by the caustic. No. 16 gage tubes should do for practically all cases. While No. 18 gage tubes would be suitable in many instances, the heavier material is preferable, as it will stand more rolling into the tube sheet thereby making a tighter joint.

The shells can be of cast iron or steel. Cast iron is preferable on account of its greater resistance to corrosion, and can be used to advantage wherever considerations of strength permit.

The size of the tubes can be from $\frac{5}{8}$ in. to 1 in., depending on the number of tubes to be used, and the desired velocity and the various other considerations that enter into the design of a heat exchanger. It might be thought that tubes as small as $\frac{5}{8}$ in. would give trouble from stopping up, but in a number of installations known to the writer such trouble has not occurred. The continuous blowdown stream is taken from the upper portion of the boiler where no concentrated sludge is drawn into it, and it flows through the tubes at such a velocity that no deposits accumulate in them.

The continuous blowdown water is preferably drawn from the upper portion of the boiler just below the minimum permissible water level. This prevents losing too much water in the event of any accident to the blow-down system and also minimizes the chance of shots of sludge getting into the blowdown line.

The use of continuous blowdown does not entirely eliminate the use of the regular blowdown valves. They should be opened occasionally say once per day or as conditions require, to discharge any dirt or sludge that may have accumulated in the mud drums, but the amount of water so blown off need be very little. If there is suspended matter in the boiler water it will be carried around by the circulation and in part will be discharged through the continuous blowdown line, but some will settle in the mud drum.

Continuous blowdown has been applied to evaporators as well as to boilers because the use of an evaporator transfers the blowing down from the boiler to the evaporator, and the density of the water in the evaporator must be held below a certain point to prevent carry-over of an excessive amount of solids into the feed supply.

▼

Rebuilt Trollhättan Plant Shows Increased Efficiency

By GEORGE WILLOCK

THE Trollhättan power plant, owned by the Swedish Government, consists of thirteen double-cased Francis turbines with a total output of 175,000 hp. on a head of 100 ft. The first units were put in in 1909 and the last in 1918.

Owing to the increasing demands for more power, the question arose as to whether a greater output could be obtained by rebuilding the older units, and after careful investigations, with models, the Royal Board of Water Falls decided to rebuild three of the older units. This rebuilding entailed new runners, gate apparatus, draft chests and shafts, while the existing penstocks, pressure casings, draft tubes and governors were used.

Three of the rebuilt units are now in operation, and tests on the last one installed show that the output has been increased from 12,500 to 18,000 hp., and the efficiency obtained was 92 per cent as compared with 87 per cent on the old one.

Owing to the excellent results obtained, an order for rebuilding two more units has just been placed with Nydqvist & Holm Aktiebolag, bringing the number up to five, but it is possible that this will be increased to seven in the near future.

▼

TO MEET modern operating conditions every care should be given to selection of steam cylinder oils for such service. Primarily any such oil should be able to withstand the prevailing steam temperatures. The higher the lubricant's flash and fire points the more effectively will this be accomplished. It is most important to remember, however, that under modern conditions of pressure and superheat the steam temperatures may sometimes be higher than the flash and fire points of certain types of cylinder oils. But if the viscosity or body is sufficient to insure adequate film strength on the cylinder walls and valve chest surfaces, to prevent metallic contact between the opposing surfaces of the pistons and valves, dependable lubrication will result.

Vibration in High-Speed Motors:

Its Causes and Remedies

High-speed motors supplied from frequency changer sets are coming into wide use. These motors may develop vibration for reasons not encountered with general-purpose types. The causes of this vibration, in which critical speed is a major factor, are investigated and suggestions made on how the trouble may be avoided

By DAVID TURCOTT
Beloit, Wis.

CONDITIONS of alternate increase and decrease of vibration in electric motors and other high-speed rotating machines are particularly pronounced in centrifugal separators, wood-working shapers, moulders and routers, grinding spindles, etc. Such machines are either belt driven or equipped with two-pole motors operating on frequencies of from 80 to 300 cycles which give synchronous speeds of from 4,800 to 18,000 revolutions per minute.

Under certain conditions the vibration in high-speed spindles seems to come and go in waves or surges, gradually increasing for a short period lasting perhaps 5 to 10 sec. After reaching a maximum the vibration begins to die away and the spindle operates smoothly for a few seconds until the next surge of vibration arrives. The interval between the surges of vibration may be equal at certain times and, irregular at other times, depending on the conditions causing the surge. The common cause of vibration surges is the proximity of operating speeds to the critical speed of the shaft and the fluctuation of operating speed which causes the shaft to approach to and recede from the critical speed.

All rotating shafts vibrate at an increased rate with each increase in speed which is due to the centrifugal forces created by the displacement of the center of gravity of the rotating parts. As the speed is increased a point may be reached at which the vibration suddenly increases in amplitude and, as the speed is still further increased, the amplitude of vibration again decreases. The speed at which the rotating body reaches a state of maximum vibration is known as the critical speed. At this speed the number of natural vibrations per minute corresponds closely with the revolutions per minute of the spindle. The speed at which this phenomenon occurs depends on the stiffness of the shaft, that is its resistance to flexure, while the maximum amplitude of vibration at the critical speed depends on the friction resistance and the amount of unbalance.

The relation between the amplitude of vibration and the speed of the shaft is shown in Fig. 1, in which the ratio of the speed of revolution to the critical speed is plotted on the horizontal line and the relative amplitude of vibration is represented by vertical distances. The vibration reaches a maximum value when the ratio of speed of revolution to the critical speed equals 1, that is, at the critical speed. The amplitude decreases rapidly either above or below the critical speed. In Fig. 1 the two vertical dotted lines indicate approximately the limits of violent vibration on either side of the critical speed. The percentage of critical speed at which vibration begins to increase rapidly depends on the damping effect of friction and varies widely for different spindles, due to air resistance, bearing construction, lubrication and other factors. In Fig. 1 the dotted lines are shown about 15 per cent on each side of the critical speed, merely to illustrate the principles involved.

When the stiffness of the shaft, that is its resistance to flexure under a given load, is such that the operating

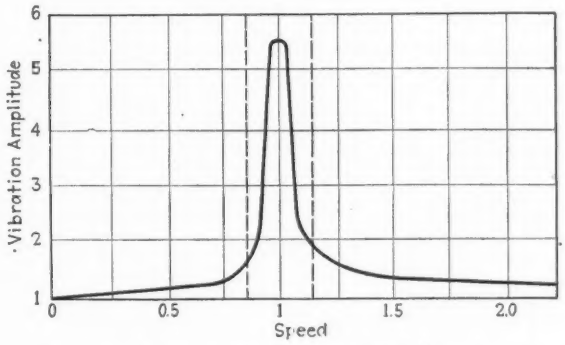


Fig. 1—Relation between shaft vibration and speed

speed is considerably above or below the critical speed, the shaft will operate smoothly. When the operating speed is so near the critical that it comes approximately within the range bounded by the two dotted lines, Fig. 1, the spindle will vibrate continously. If, however, the normal operating speed happens to be so near the range of high-vibration amplitude that the speed fluctuations cause it to approach and recede from the area of high amplitude there arises a condition of vibration surge.

Causes of Speed Fluctuation

Fluctuations of speed sufficient to cause vibration surging may be due to belt slip, slip in induction motors when the load increases, increased slip due to drop of voltage, change in line frequency and other causes. Fluctuation in line frequency is encountered only when the alternator is driven by a poorly governed prime mover; voltage changes are quite common but the changes do not occur in frequent intervals. The greatest fluctuations of speed are encountered in motors operating on high-frequency power supplied by induction-type frequency changers. An induction frequency changer as illustrated in Fig. 2 consists of a wound-rotor type induction motor driven by another induction motor. The stator of the frequency changer is electrically connected to an alternating-current source of standard frequency and the high-frequency power is generated in the rotor by rotating it in a direction opposite to which it would run as a motor. The high-frequency power is delivered through the slip rings and brushes to the high-speed motor on the machine. Usually the frequency changer supplies high-frequency power to more than one machine. While a synchronous motor is an ideal motor for driving a frequency changer, it is customary to use a standard squirrel-cage motor on account of low first cost, reliable operation and low maintenance cost.

When the high-frequency power is supplied by an

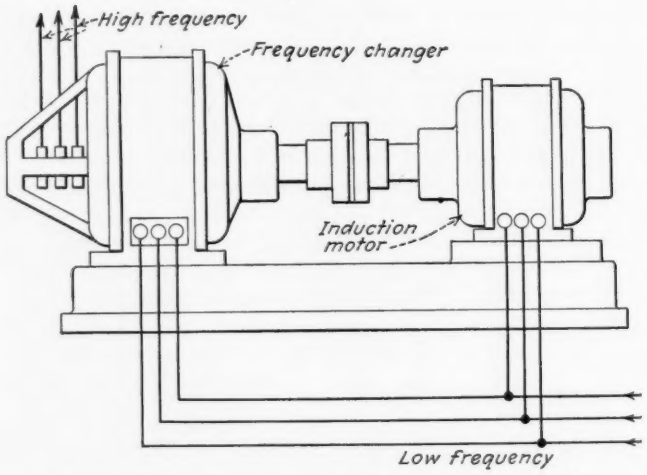


Fig. 2—Diagram of an induction-type frequency-changer set

induction-type frequency changer there are three major causes of speed fluctuation affecting the speed of the high speed motor: the slip of the motor driving the frequency changer; the voltage drop in the frequency changer; and the slip of the high-speed motor.

The frequency generated in the rotor of the frequency changer varies directly as the speed of the driving motor, and the total frequency delivered at the slip rings equals the generated frequency plus the line frequency supplied to the stator. The high frequency delivered by the frequency changer may be calculated from the following:

$$F = \frac{PS}{120} + f \qquad (1)$$

where F = High frequency in cycles per second.
P = Number of poles in the frequency changer.
S = R.P.M. of motor driving the frequency changer.
f = Low frequency supplied to stator of frequency changer in cycles per second.

The reduction of frequency due to the slip of the driving motor may be found by subtracting the frequency

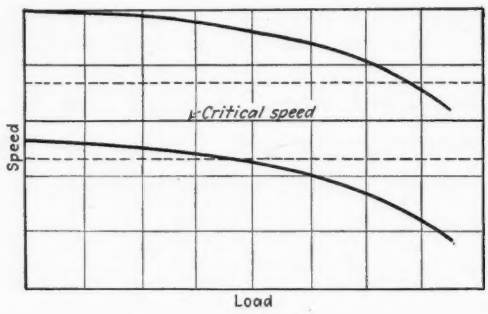


Fig. 3—Curves showing relation between speed and load of high-speed motors

obtained by substituting full-load speed in equation (1) from the frequency obtained by the same formula using the synchronous speed of the motor, or

$$F_e = \frac{P\,(S_s - S_f)}{120} \qquad (2)$$

Where F_e = Loss of frequency in cycles per second.
S_s = Synchronous speed in revolutions per minute.
S_f = Speed in revolutions per minute at full load.

The loss of speed in the high-speed motor due to drop of voltage depends on the voltage regulation of the particular frequency changer. The slip of an induction motor varies approximately inversely as the square of the voltage. Hence it follows that the slip increases at a faster rate than the drop of voltage. Now, the full-load slip of a high-speed motor is usually from 3 to 6 per cent at a constant supply voltage and frequency. To this slip must be added the slip due to voltage drop and frequency loss of the frequency changer.

When the three causes of speed fluctuation are added it will be found that the speed of the high-speed motor may vary up to 15 per cent in some cases. If more than one machine is operating from the same frequency changer, any fluctuation in the load of one machine will have an effect on the speed of other machines even if the other machines are operating at a constant load. Hence, a high-frequency motor, even when running idle, will fluctuate in speed if the frequency changer is supplying power to other machines.

As has already been shown, wide fluctuations in speeds are encountered in practice, particularly in high-speed spindles. Now examine Fig. 3 in which the two curves illustrate speed changes. The upper one represents operating speeds above the critical speed and the lower one, speed of a machine operating below the critical speed.

The dotted lines in this diagram represent approximate limits of smooth operation. The maximum vibration occurs at the critical speed half way between the two dotted lines. In the case of machines operating above the critical speed the vibration surges will occur when the speed is lower, while the reverse is true when the operating is below critical.

Vibration May Be Avoided

Vibration surges may be avoided by so designing the shaft that the operating speed is remote from the critical speed. The more constant the operating speed the nearer it is possible to approach the critical speed without encountering vibration surges. Whenever it is economical, the frequency changer should be driven by a synchronous motor. This is practical in the larger sizes. The frequency changer should be placed as near as possible to the high-frequency machines to avoid excessive voltage drop in the high-frequency line. The use of extra heavy wires for high-frequency lines is good practice. In some cases high-frequency power requirements are great enough to justify an installation of high-frequency alternators. An alternator driven at a constant speed and supplied with an automatic voltage regulator will deliver power at a constant frequency and voltage that is difficult to obtain with a frequency changer.

Vibration surges are objectionable because of the variable pitch noise which is often more annoying to operators than a noise or hum of constant pitch. Another important factor is the influence of speed fluctuation on the quality of work. This is particularly serious in woodworking machines and high-speed grinders.

▼ ▼ ▼

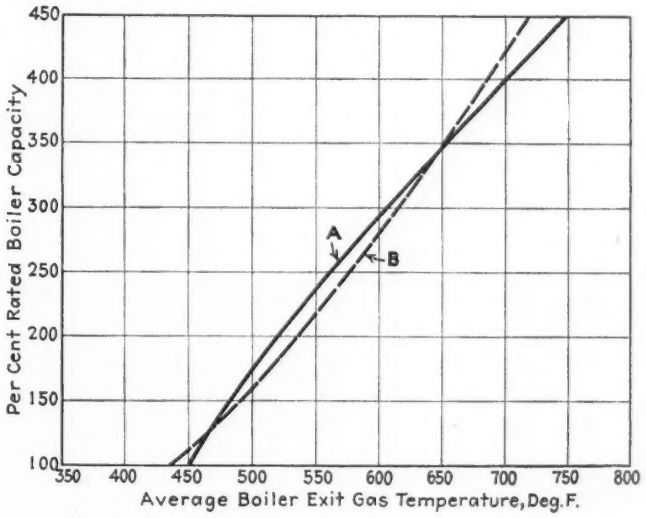
Flue-Gas Temperature From Boiler Rating

By J. R. DARNELL

FREQUENTLY in power plant practice combustion calculations require that boiler exit-gas temperatures be known or assumed. If the latter, the question arises as to what would be considered a fair representative temperature for a given boiler rating, say 350 per cent. Authorities do not agree on this question although in the author's own experience discussions have been verbal and he does not recall having read opinions on this subject in print.

Temperature of the flue gas at the boiler exit is dependent on a number of variables which affect the furnace temperature, since it is the latter which actually controls the exit-gas temperature. It is generally agreed that the higher the furnace temperature, the lower the exit gas temperature. It is also true that with exactly the same furnace temperature and the same mass velocity of gas through the tubes, theoretically, a boiler twenty tubes high should have a lower exit-gas temperature than one sixteen tubes high.

But there are so many variables controlling the furnace temperature and the weight of gas through the tubes that boiler exit-gas temperatures are not necessarily proportionate to the length of gas passage. A study of a large number of boiler tests indicates that in certain cases boilers twelve tubes high have exit-gas temperatures about the same as those twenty tubes high. In some cases they are somewhat lower. This may be due to higher furnace temperatures which permit a higher rate of heat transfer in the first pass. The higher furnace temperature means less excess air, and, consequently, a lesser weight of flue gas which in the convection section of the boiler results in lower mass velocity and, therefore, a lesser rate of heat transfer in this portion of the boiler. In some cases the one condition may offset the other so that the final exit temperature for a given boiler rating is about the same regardless of the number of tubes or length of gas passage.



Valves of exit gas temperatures for different boiler ratings

The curves show values of boiler exit gas temperatures for boiler loads from 100 to 450 per cent of rating. In the author's opinion the shape of the curve should be as shown by *A*, although in a few cases test data apparently have indicated the shape of the curve to be as shown by *B*. Boiler manufacturers occasionally in submitting boiler quotations also indicate the shape of the curve to be as shown by *B*. In the great majority of cases, however, the author has found the shape of the curve to be as shown by *A* and the values to be fairly representative for three-pass water-tube boilers.

For example, suppose a fan salesman is asked to quote on an induced-draft fan for a boiler intended to be operated at a maximum of 350 per cent rating. The customer does not know what the exit-gas temperature will be at this load and some one, therefore, must make an intelligent guess. In cases like this the author has found the values shown by curve *A* to be fairly accurate and reasonably close to the conditions for estimating purposes.

Perhaps other readers have additional data either supporting or contradicting the author's observation, which they would like to present.

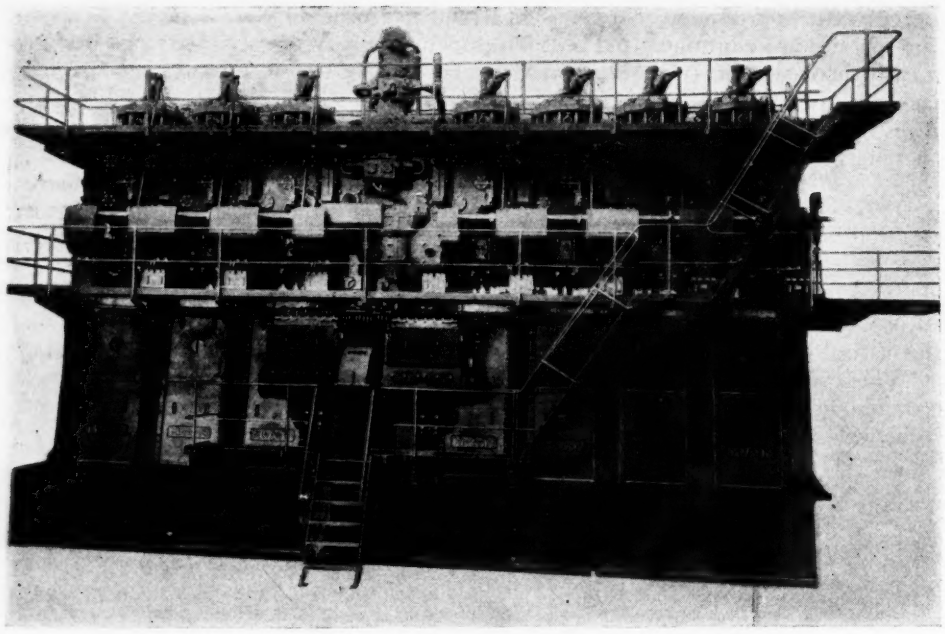


Fig. 1—A 7,000-hp., double-acting, two-cycle, German, solid-injection diesel

BY ALAN CRAIGON
Consulting Engineer
Toronto, Canada

The Double-Acting Diesel

APART from the engineering difficulties involved, the greatest retardation to the advent of a commercially successful two-stroke-cycle double-acting diesel engine of moderate powers has been and still is the preponderance of standardized single-acting engines, with consequent reluctance on the part of established manufacturers to adopt the two-stroke-cycle double-acting engine on its merits.

Economic considerations and standardized production have done much to lower the unit cost of prime movers in general, but when manufacturers almost uniformly reject change mainly from fear of the cost involved in re-tooling a plant to make way for a demonstrably newer and better type of machine, they must be compelled by some external force, such as buyer-demand, to change that state.

For similar engines running at, say, 1,000 r.p.m. the impulses *N* per minute would be as follows for the various types:

A. Four-stroke-cycle, single-acting..... 500
B. Four-stroke-cycle, double-acting.....1,000
C. Two-stroke-cycle, single-acting.....1,000
D. Two-stroke-cycle, double-acting.....2,000

It will be seen from this that were all other factors the same engine *B* would give the same horsepower output as engine *C*; engines *B* and *C* would give twice the output of engine *A*; engine *D* would give twice the output of engines *B* and *C* and four times the output of engine *A*. In other words, the output is directly proportional to the impulses per minute and not necessarily only to the revolutions per minute.

Since engines *A*, *B*, *C* and *D* may be facsimilies so far as stroke, bore, revolutions and mean pressures are concerned, and on the assumption that they all have the same friction and mechanical losses, the same number of working parts, cylinders and connecting rods, it follows that engines *B* and *C* would be half as heavy per horsepower as engines *A*, and further that engine *D* would be half as heavy per horsepower and engines *B* and *C* and only one quarter as heavy per horsepower as engine *A*. It follows that there will be approximately the same amount of labor and material in all four engines, so that the cost per horsepower would decrease in the same ratio as the weight per horsepower. As a matter of fact, there are so few parts in the two-stroke-cycle double-acting engine as compared with the others that the cost and weight reduction is even better than the theoretical reductions arrived at in the above manner.

It is a noteworthy accomplishment that the weight of the average diesel has been reduced from, say, 400 lb. per brake-horsepower 20 years ago to the present-day low values of 15 lb., 12 lb., and even 2.75 lb. per horsepower in some special cases recently built on the four-stroke-cycle, single-acting, high-speed principle.

As this weight reduction has been accompanied by an increase in price per horsepower to some three to four times the normal price per horsepower, it follows that since outputs from these light high-speed, single-acting, four-stroke-cycle engines have reached the maximum within the reasonable expectations of reliability, the two-stroke-cycle double-acting engine offers the only remaining hope for offsetting the large increase in unit price and causing further relative weight and price reductions per unit due to increased output from a given number of cylinders of the same bore and stroke. Alternatively, without the use of any other than ordinary metals of construction such as close-grained cast iron and mild steel, both a reduction in weight to horsepower ratio and cost per horsepower becomes obtainable by means of a suitable two-stroke-cycle, double-acting machine. Or, as a second alternative, a large reduction in unit price may be effected without appreciable reduction

The author has devoted the last 10 years to the investigation of increased power output possibilities from the diesel oil engine. As a result, he has concluded that the two-stroke-cycle double-acting type offers by far the best technical and economic solution for this purpose, and his latest developments are now being built under license by a large engineering concern in Great Britain. During the exploitation period of his own two-stroke-cycle double-acting designs, he observed much about this type of engine in contrast to single-acting types, which he feels should be recorded for the benefit of those who are interested in the development of the diesel engine

of the Future

in weight per horsepower and slower rotational and piston speeds and lower mean effective pressures used, with consequent increase in engine life and lowered maintenance costs.

The reduction in cost and weight per horsepower is most readily obtained by increasing the horsepower output from an engine of given stroke, bore and number of cylinders.

It is evident that if the compression pressure is increased, the mean effective pressure during the ensuing working stroke will have a higher value. However, an increase in compression pressure would require much stronger cylinders and cylinder heads and more robust construction generally, and there is obviously an economic limit to which this compression may be carried. Just as in steam practice, an increase in pressure brings about increased thermal efficiencies, but soon one reaches a point where the capital invested plus the interest and maintenance charges thereon more than offset the increment in thermal efficiency.

Furthermore, without the use of light, high-tensile-strength metals, an increase in compression pressure would run up the weight per horsepower, quite apart from the fact that light, high-tensile-strength metals are basically expensive because of their relatively small total production and the length of time required for the heat and metallurgical treatments. It is obvious that any decrement in special metal costs and their use in a four-stroke-cycle, single-acting diesel would soon be extended to the two-stroke-cycle, double-acting types and the four-stroke-cycle advocate would be relatively no further ahead. Higher compression pressure is therefore only desirable from the standpoint of increased thermal efficiency, and would result in no appreciable reduction in weight or cost per horsepower.

It is significant that the Maschinenfabrick Augsburg Nürnberg in Germany did build four-stroke-cycle, double-acting engines up to 1912, in which year the company abandoned the type as too heavy and complicated. The largest four-stroke-cycle, double-acting engines built to date are those in the M. S. Britannic. They are rated at 10,000 hp. each. The 15,000-hp. M.A.N. Blohm & Voss unit at the Hamburg Electricity Works takes up much less room than one of the Britannic engines.

Turbine manufacturers are striving to increase their thermal efficiencies by means of increased steam pressures and total temperatures. The turbine has the additional advantage that its cost decreases and efficiency increases as the size of the unit increases, whereas the diesel's thermal efficiency is about the same for all sizes. However, even on a parity basis as to thermal efficiency, should the diesel become constructable in sizes of, say, 50,000 to 75,000 hp., as in the case of the turbine today, it will still have great advantages over the steam turbine if only in the absence of large batteries of boilers and all the auxiliaries inseparable from a boiler plant. The

Fig. 2—A view of a Worthington double-acting, two-stroke-cycle air-injection diesel

M.A.N. designers have turned to the two-stroke-cycle, double-acting engine and it is understood that the greatest four-stroke-cycle advocates and builders, Burmeister & Wain, have also developed a two-stroke-cycle, double-acting design. Judging from a well-known authority, Heinrich Becker, chief engineer of the M.A.N., 25,000 hp. per shaft with two-stroke-cycle, double-acting diesels and total installations of 100,000 and even 180,000 hp. are not beyond the powers of present development. Tentative plans of this nature emanating from one like Mr. Becker of a company so highly successful as the M.A.N. cannot be put aside as purely visionary.

It is evident that only the two-stroke-cycle, double-acting diesel bulks at all large as a serious competitor of the steam turbine in the sizes so necessary for large marine and stationary power-generating plants. Some progress has been made by some manufacturers toward large blocks of power for motorships by means of a plurality of single-acting units direct connected to generators which are electrically tied together and drive two or more propeller-shaft electric motors. This method is obviously so expensive as to be prohibitive except in the few cases where cost does not bulk so large, as in battleship construction. There is also the disadvantage of considerable losses in the generators, switchgear, control and the electric driving motors.

Large Diesels for Battleships

The author has held for several years the view that the advent of the 50,000- to 60,000-hp. diesel would have a marked influence on the efficacy of warships generally and incidentally a noticeable effect on the limitation of naval armaments based on displacement tonnage. Ships such as the U. S. aircraft carriers Lexington and Saratoga or the H.M.S. Hood and Rodney generally require from 150,000 to 180,000 hp., usually distributed over three propeller shafts with 50,000 to 60,000 hp. on each. The elimination of the large number of boilers, steam mains and steam auxiliaries now used in warships plus the increased thermal efficiency of the diesel would considerably increase the cruising radius of both surface and sub-surface craft, so that opportunity for any naval power with a limited number of rather badly scattered naval bases would be greatly improved. As less over-all weight per horsepower is taken up with diesel power plants, the balance of permitted weight may be used for stronger armoring and heavier guns.

Increased submarine efficiency is dependent almost wholly on the amount of diesel power that may be installed in the severely limited space available. The marked improvement shown when two-stroke-cycle, single-acting engines were first installed in submarines will undoubtedly be extended by the use of the two-stroke-cycle, double-acting high-speed types that are bound to be developed if the subject is given the attention it so well merits.

The reader will no doubt feel that economic considerations alone could not have held back the two-stroke-cycle, double-acting engine to such an extent without there being other contributory reasons. This is true. When the first two-stroke-cycle, double-acting engine was designed it was natural for the designer to follow established double-acting steam practice and adopt a piston rod passing through a stuffing box and gland in the bottom cylinder cover and a crosshead which housed the small end of the connecting rod. For a century or more this has been the orthodox means of making a single-acting machine into a double-acting one, be it steam engine, reciprocating pump or reciprocating air compressor. The essential mistake in this practice applied to double-acting diesels was in overlooking that in steam practice the piston rod was never called upon to pass through a stuffing box that had to seal off maximum gas pressures perhaps as high as 600 and even 700 lb. per square inch without ruining the packing.

In addition to the pressure question, the steam piston rod is never subjected to more than 400 to 500 deg. F. vapor temperature, whereas the diesel piston rod is subjected to incandescent-gas temperatures of 3,000 to 3,500 deg. F. A further difficulty was that for the same cylinder bores as steam practice the diesel piston rod would have to be of much greater diameter because it must convey cooling oil or water up into and out of the piston proper, a duty it is never called upon to fulfill in any steam engine.

This unavoidable piston-rod diameter increase has the additional disadvantage of cutting down the effective piston area at the bottom end and complicates to a most despairing degree the problem of accommodating valves in the lower end. Where the port-scavenging method is adopted the piston is substantially the same length as its stroke, to act as a piston valve controlling the opening and closing of the scavenging and exhaust ports. This long piston rod further complicates efficient scavenging and fuel injection. A centrally disposed fuel-injection valve in the top end and fuel capacity necessarily divided into two for the bottom end duplicate injection valves tends to aggravate the unbalanced pressure conditions between top and bottom. The author was told recently by one of the manufacturers of large double-acting diesels in England that he frequently has one of the two bottom fuel injectors plug up while the other continues to inject. Flame thus hitting one side of the rods has caused as much as $\frac{3}{8}$- to $\frac{5}{8}$-in. deflection in the rod, and the resultant condition of the stuffing box, gland and lower head may be imagined with a rod in this bent condition passing through it for any length of time.

Compromise Engines

Another compromise between straight two-stroke-cycle, double-acting and some of the advantages of the double-acting is to be found in the opposed-piston types of engines such as the Junkers, Doxford and Fullagar. The uniflow scavenging system is to be commended, as it gives a definite bodily displacement of the exhaust gases without definite dependence on accurate deflection of the incoming scavenging air. The author understands that Junkers has had some success with this type even in the air, in which type the pistons fly outwards toward two crankshafts geared to a central propeller shaft with a ratio that gives the required propeller speed and does away with manipulation of engine characteristics to obtain correct propeller speed. No doubt the balance of such an engine will be good as both the reciprocating and rotating masses will be acting in the same plane and will be equal and opposite.

It is safe to say that except for marine and large stationary purposes, the orthodox two-stroke-cycle, double-acting design will find little application in any of the other fields. These other fields do require a two-stroke-cycle type, but it will have to be something radically different from the orthodox kind. Radically different types are bound to evolve for these other applications, and it is to be hoped that this article may result in a closer study of such feasible new designs as do appear.

Moscow Boilers Will Operate At 1900 lb. and 932 deg. F.

THE Witkowitz Corporation of Czechoslovakia has recently received an order from the Technical Institute of Moscow for two complete Loeffler boilers to operate in Europe's largest high-pressure power plant. Each unit will supply 285,000 lb. steam per hour in normal operation and a maximum of 350,000 lb. for short peak loads. The steam pressure will be 1,900 lb. per square inch and the total steam temperature 932 deg. F.

Highest Steam Conditions in Europe

The Moscow station, besides being the largest in size, is the only European power plant which operates at such high steam temperature and pressure. Russian engineers spent many weeks in Witkowitz studying the four Loeffler boilers in operation there. The following gives technical data relative to the boilers ordered for Moscow.

The feed water is brought to a temperature of 410 deg. F. in bleeder heaters, where it is raised to 485 deg. in economizers before it enters the vaporizer drums.

Saturated steam, leaving the vaporizing drums at 1,900 lb. and 628 deg., is delivered by the booster circulating pump to a radiant superheater consisting of U-shaped tubes. These line two adjacent furnace chambers on all sides with the exception of the ceilings.

Will Burn 4,900-B.t.u. Coal

It is planned to burn "Donez" coal of 12,200 B.t.u. per pound lower heating value at first and to fire later on Moscow coal of 4,900 B.t.u. per pound lower heating value. These Loeffler boilers will burn the coal in pulverized form and means are provided to dry the raw coal before it is pulverized.

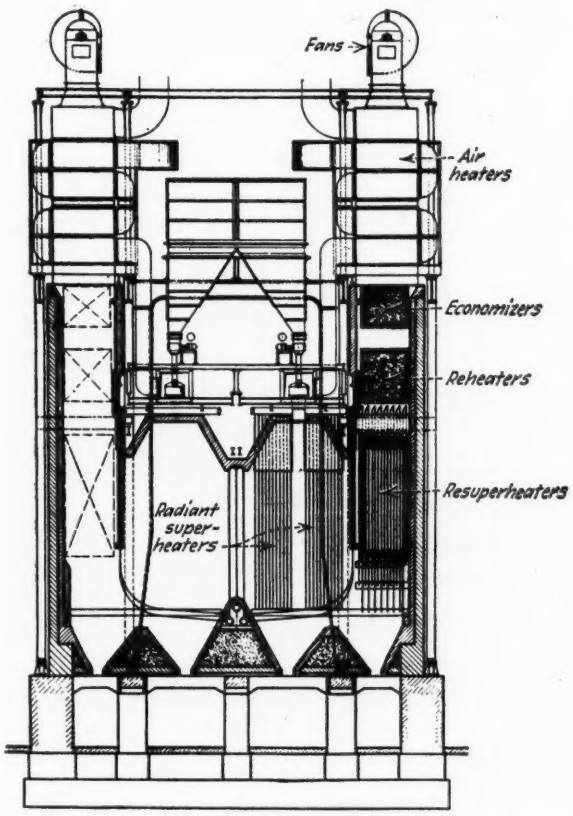


Fig. 1—Vertical section of Loeffler boiler for Moscow installation

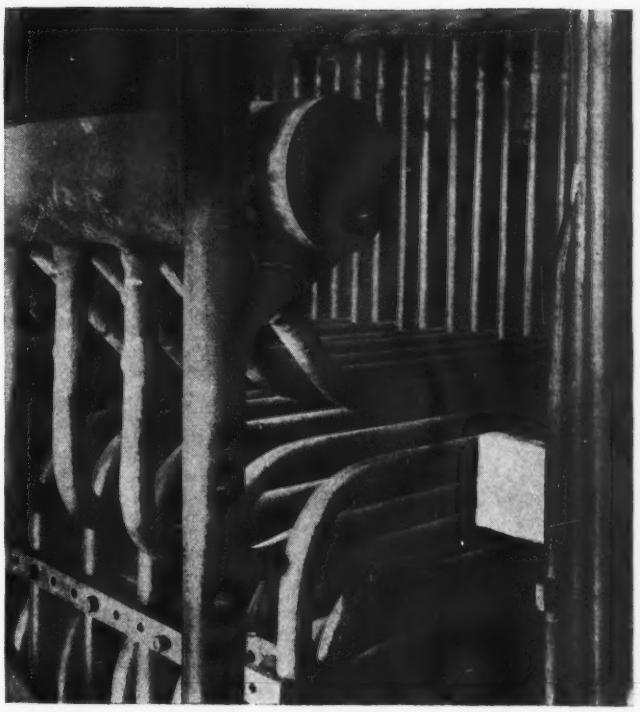


Fig. 2—This type of welded construction will be used in the Moscow boilers

The pulverized coal is first brought into a bunker above the furnaces, whence the fuel is supplied to two rows of eight burners each, where it is thoroughly mixed with air of 485 deg. F. temperature. The double furnace chamber has a cubical content of 21,180 cu.ft., the radiant-superheater surface being 3,120 sq.ft. After leaving the furnace chamber, the gases branch off at right and left and sweep in their second path the other heating surfaces of the boiler.

There they pass the resuperheaters (convection type), each of 10,760 sq.ft. These have 48 flat tube coils of the type shown in Fig. 3. Each tube is of 2.75 in. outside

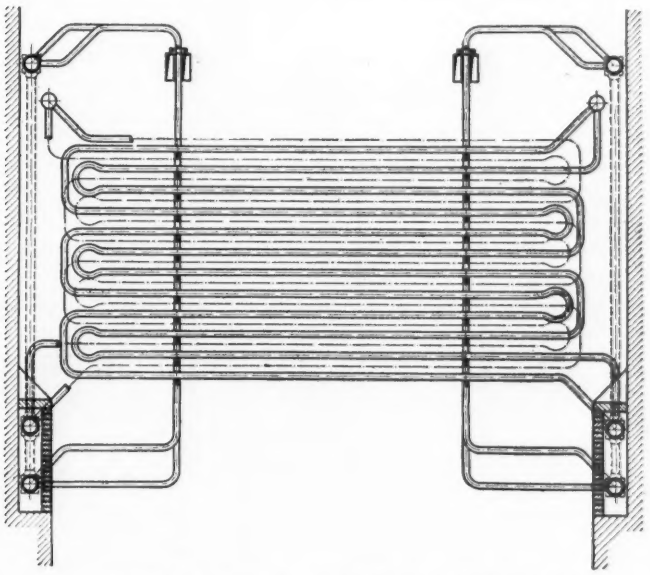


Fig. 3—Coils of this type line the furnace chambers, forming a radiant superheater with an aggregate surface of 3,120 sq.ft.

diameter. Steam leaving the radiant superheaters at 735 deg. is here raised to 932 deg., after which about one-third goes to the turbine and two-thirds to the vaporizer drums.

Above the resuperheaters are the reheaters, which reheat steam of a pressure of 380 lb. from 535 deg. F. to 752 deg. F. The heating surface of these reheaters is constructed similarly to that of the resuperheaters. Each measures 6,886 sq.ft. and consists of 32 flat pipe coils of 1.87 in. outside diameter. These are similar to those of the convection superheater.

Above the reheaters are the two economizers, each of 6,080 sq.ft. Above these, in turn, are air-reheaters of Witkowitz Thermorex design.

Above the air preheaters is the induced-draft plant formed by two suction fans, each designed for a maximum of 140,140 cu.ft. of gas per minute with gas temperature of 410 deg. F. The delivery ducts of these fans enter a gas filter, whence the gases leave through short stacks.

Five Vaporizer Drums per Boiler

Each boiler has five vaporizer drums 26 ft. long with a diameter of 43 in., besides one mud drum of the same diameter but only 6 ft. 6 in. long.

For the circulation of the steam each boiler has a single-stage, turbine-driven, centrifugal booster pump. It is able to move 1,100,000 lb. of saturated steam per hour.

The foregoing information has been furnished by Arthur Herschmann, New York representative of the Witkowitz Company.

▼ ▼ ▼

Preventing Over-Speeding of An Aerial-Tramway Motor

By R. F. EMERSON

Industrial Engineering Department, General Electric Company

AERIAL TRAMWAYS are sometimes used for transporting coal to power stations and for the disposal of ashes. The figure shows a diagram of connections for a 60-hp., 440-volt, 3-phase wound-rotor motor used to drive an aerial tramway, where it was desired to guard against run-away conditions due to the load sometimes overhauling the motor. Of course, the motor would regenerate and brake the load at a safe speed if the controller handle was always left in the full-on position. On the other hand, if the controller handle were left in an intermediate position, the tramway would overspeed, depending on the amount of resistance left in the secondary circuit.

In order to guard against any possibility of over-speeding, a reverse-power relay was installed that would close its contacts on reversal of power and cause the slip rings of the hoist motor to be short-circuited by a contactor *M*. If the controller handle was already in the full-on position, this operation of the relay would not affect the operation of the motor. Should the controller handle be left in one of the intermediate positions, the closing of the reverse-power relay would cause contactor *M* to close and short circuit the motor's slip rings, and would have the same effect as though the controller were full-on.

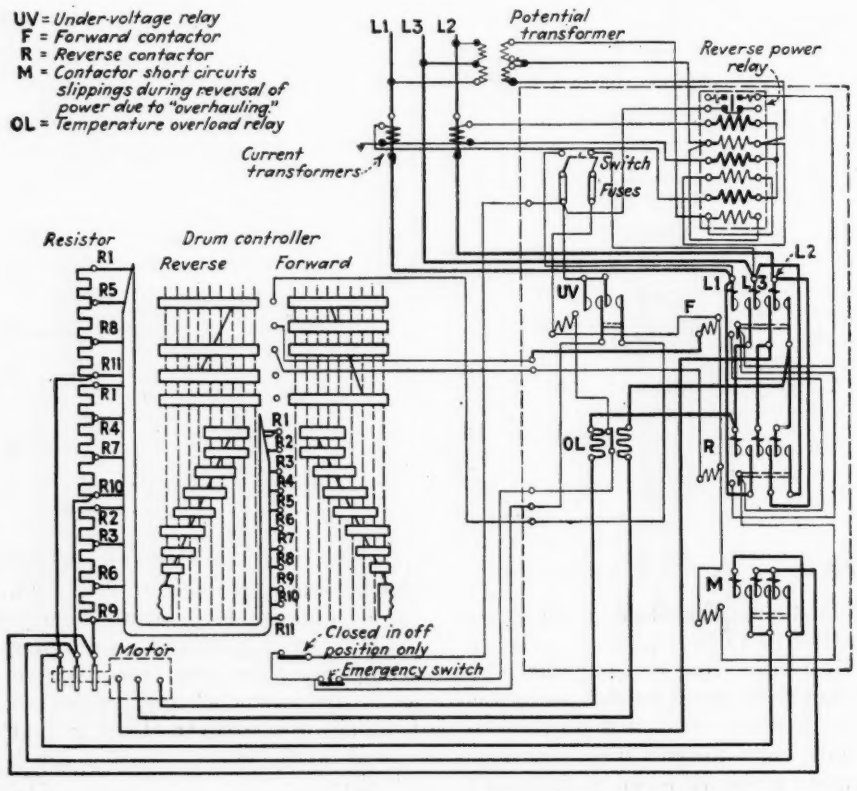
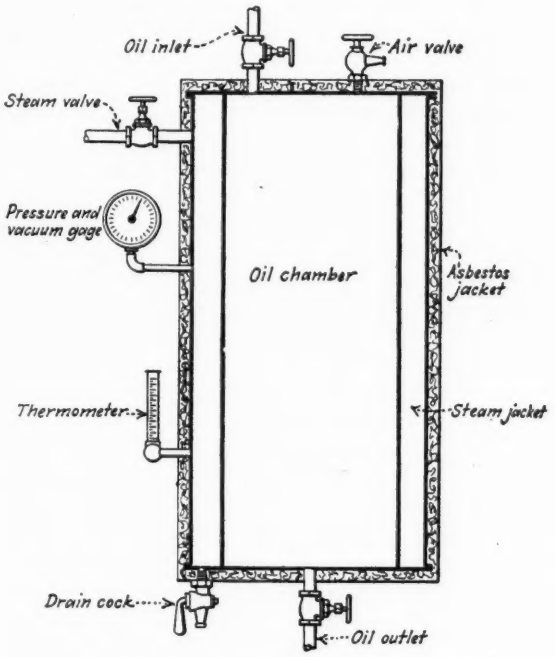


Diagram of connections for aerial-tramway motor control

PRACTICAL AIDS TO OPERATION

Oil-Storage Thermos Flask

AN OIL-STORAGE thermos flash or insulated vessel designed to hold a certain quantity of oil at a temperature suitable for quick starting over short shutdown periods is show in the illustration. To use this thermos flask the drain cock is first opened, then steam is admitted until the vessel is thoroughly warmed up. The air valve is opened and the vessel filled with hot oil, then both oil and



Insulated steam heated oil storage tank

air valves are closed. Steam is turned on until dry steam comes out of drain cock, when both steam valve and drain cock are closed.

The steam jacket will have to resist atmospheric pressure when the steam condenses, creating a vacuum which will register on the gage. With all valves closed tight the oil is held at the required temperature for a considerable length of time.

Montevideo, Uruguay. E. KERR.

Avoiding Complicated Valve Arrangement

IN SOME power plants and pumping stations there are large pumps, diesel engines or other machines used for emergency service, such as boiler-feed or fire protection. On most of this equipment there are a number of valves to be opened each time a machine is started, to provide water to sealing glands, oil coolers and bearings. There is usually a separate globe valve on each branch line, and when the cooler or other service has a visible discharge these valves must be set about correct to get the right flow of water.

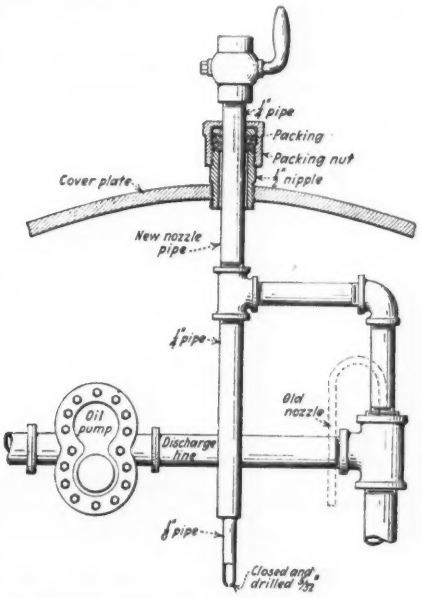
In one plant a lever-type plug-cock valve is placed in the sealing-water main just ahead of the branch lines. Each globe valve is set for the proper amount of water with the lever valve wide open. The packing nuts on the globe valves are drawn up tight enough to hold the valve in this position. The lever valve is then closed off. By doing this in a service where time is valuable the lever may be swung up when starting and all cooling water is on in this one operation.

H. M. SPRING.

Milford, N. J.

Cleaning the Diesel Oil-Pump Nozzle

OUR DIESEL ENGINES are equipped with valve devices that shut off the fuel supply whenever the pressure fails on the lubricating oil line. The pressure is created by an overhead tank above the engines, into which the oil pump, driven by the engine crank shaft, discharges the oil as pumped. In spite of filters and changing the oil often, the relief nozzle of the pump, that prevents it from becoming airbound, stopped up. When this happened, the pump failed to deliver oil to the overhead tank, and caused the engine to stop. After several of these stoppages I devised the plan shown in the illustration. By this arrangement of the piping, the nozzle can be cleaned at any time with a piece of No. 9 telephone wire, using a wad of waste held tightly in the hand on top of the stopcock while the wire is being run through the pipe and nozzle. The cover plate was drilled and



Device to enable the oil-pump air nozzle to be cleared

tapped for ½-in. pipe, in the proper place, and an old valve packing nut drilled to fit the ¼-in. pipe snugly.

If no packing nut is available, a ½-in. pipe cap will do as well. In fact, though our piping was arranged for packing, we have never used any yet. Another advantage of this piping scheme, besides cutting down the labor of taking off the cover plates, is that a smaller hole can be used at the nozzle, since it can be cleaned so easily and often. THOS. C. HULTON.

Abras Grandes, Prov. de Camagüey, Cuba.

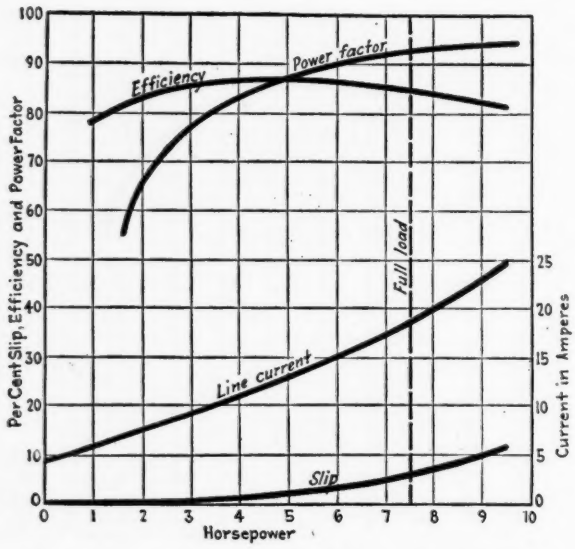
CURRENT COMMENT

Motor-Load Tests Pay

THE BENEFITS obtained from motor-load tests, mentioned in the question of C.O.H. in *Power* for Dec. 15, are: (1) Lower manufacturing costs due to lower power consumption, reduced repairs and maintenance costs and fewer interruptions to production. (2) Overloading and underloading of motors are detected and abnormal operation of machines is found before it has time to cause large power losses and unexpected failure of equipment.

Underloading of direct-current motors causes a reduction in efficiency and overloading produces sparking at the brushes and may cause the windings to fail. With alternating-current motors low power factor and low efficiency result from underloading. Where there is a power-factor clause in the power rate, low power factor may be of even greater importance than low efficiency. On the other hand, low power factor may cause overloading of feeders, transformers and generators.

If a motor is properly loaded it runs at a high power factor and efficiency and the power losses are at a minimum. The diagram shows the load characteristic



Characteristic curves of a 7.5-hp. 220-volt, 1,800-r.p.m., 60-cycle induction motor

curves obtained by test for a 7.5-hp., 220-volt, 1,800-r.p.m., 60-cycle induction motor. At full load the efficiency is 85 per cent and the power factor is 93 per cent. If the load is 25 per cent of rated value, the efficiency drops to 83 per cent and the power factor to 63 per cent.

Meter readings of motor loads should be taken at least once in summer and once in winter, because the loads in winter are usually heavier than in summer. In any event a reading should be taken every time the character of the load is likely to change.

There are a number of different meters that may be used for motor-load testing and those obtained will depend upon the money available for their purchase. The cheapest in the long run is a recording wattmeter with the necessary shunts, and transformers. We have used this type of meter for several years and found it very satisfactory. The charts are kept on file so that they are available when plant changes are being considered and for other purposes. When a motor is found to be improperly loaded effort is made to replace it with one of the correct size. CLARENCE W. HOPE.

Lowell, Mass.

Excessive Lubrication Consumption of Two-Cycle Diesel Engine

THE ANSWER to questions regarding excessive lubricating oil consumption of an oil engine, contained in the "Readers' Problems" section of the Dec. 8 number of *Power* has just been called to my attention.

Unless I am greatly mistaken, the 14x17, six-cylinder, two-stroke-cycle, crank-case-compression diesels are of a maker with whom I spent about five years previous to 1929, installing and servicing engines for the local branch of this manufacturer.

It might be well to mention a few points, gleaned from actual work on these engines, that would be hopeful to the operators of the plant where the engines are installed.

In the first place, these engines are designed to run with dry crankcases; that is, a used-oil pump is provided to remove the oil that runs off the bearings and pump it through a filter to the clean-oil reservoir. The main bearings are ring oiled from individual oil pockets beneath the journals. The oil level in these individual pockets and in the governor housing is kept at a constant predetermined level by overflows and interconnecting piping. It is absolutely necessary that all piping be kept free so that the respective level under each bearing is at its proper height, to prevent excessive oil running from the main bearings into the crankcases which might overload the used-oil pump. This would cause oil accumulations in the bases and result in dipping of the cranks, which would, of course, mix oil with the scavenging air and result in excessive consumption.

The crank bearings are ring-oiled, oil being supplied from a mechanical lubricator, so that it is easy to adjust the oil supplied these points. The cylinder walls are lubricated at three points, these being also supplied from the force feed lubricator. Two of these points are diametrically opposite and in line with spring loaded wipers in the ends of the wrist pin. The third point is directly opposite the exhaust ports.

With the foregoing points in mind, it is easy to trace possible causes of excessive oil consumption. The first and most obvious possibility is the accumulation of oil in the crank cases; in fact, I have seen engines run on oil thrown up with the incoming air in this manner, with the fuel oil shut off. I call to mind a case where a 100-hp., four-cylinder engine ran away and was completely ruined from this cause.

If the used-oil pump removes all the oil from the crank cases, this possibility is, of course, removed. It has been my experience that a little excessive oil supplied to the crank bearings has very little effect on oil consumption, as this is mostly recovered from the cases.

The next possibility is that excessive oil is being supplied to the cylinder by the force-feed lubricator, and this has been found in a large majority of cases to be the reason for excessive oil consumption. The reason for this is apparent when the design of the engine is considered in detail.

On most of the engines of this size, a considerable area outside of the pistons in line with the wrist-pin bosses is relieved, as is common practice, in order to prevent piston distortion due to the wrist pins causing the pistons to swell against the cylinders at these points. These relieved areas extend around the circumferences of the piston so far that the ends overlap the edges of both the intake and the exhaust ports when the piston is down. The result is that the pressure built up in the crankcase when the piston travels downward blows oil from the points of introduction at the cylinder walls out through the exhaust ports. The only solution of this difficulty is to reduce the oil fed to the cylinders to the absolute minimum. Too much oil is sometimes as bad as too little. The joker connected with this adjustment is that the person making the adjustment must be thoroughly familiar with the appearance of the piston and cylinder walls and exhaust ports when properly lubricated, as well as with wrist pin and upper connecting rod temperatures, to be able to arrive at the proper adjustment, for it is, of course, necessary to supply sufficient oil to keep the wrist pin lubricated and still prevent an excessive amount going out of the exhaust ports. A certain amount of this oil is carried up into the piston space and, when supplied in copious quantities, would result in a considerable loss as well as carbon formation in exhaust ports and piping.

As the speed of an engine driving an alternator is constant, the same amount of oil is fed by the lubricator at all times regardless of load, therefore the load at which the engine is to operate must be considered when cylinder lubrication is adjusted. I have found that by carrying out the following procedure a very good adjustment of cylinder lubrication can be arrived at in a relatively short time. Of course minute adjustments have to be made for a considerable period of time during operation of the engine. If the engine is to be operated part of the time at full load, it will be necessary to adjust the lubrication to these conditions, therefore the engine is run at full load for a couple of hours so as to get it thoroughly warmed up, then is stopped and inspection plates removed from the exhaust pipes and the exhaust ports examined to see whether or not oil is being blown into them from the cylinder. If they appear wet around the edges, indications are that an excess amount of oil is being fed to the cylinder. Oil supplied to the intake side is then cut down according to the judgment of the party doing the adjusting and it may be also possible to cut down the oil to the other two points in the cylinder if, in the judgment of the operator, too much oil is running down the connecting rods from the wrist pins. This could be easily determined by removing the base plates. After this adjustment the engine is again run at full load and the procedure repeated until the point is reached at which the exhaust ports and bridges appear perfectly dry, keeping in mind, of course, that sufficient oil must be fed to the wrist-pin wipers so that pins will at all times be well lubricated.

The procedure is based upon the assumption that the engine cylinders and rings are in fairly good operating condition and that the lubricating oil used is of a make and viscosity recommended for this engine by the manufacturer.

While definite figures are not at hand at present, it is my recollection that I have been able to obtain from 1,800 to 2,400 hp.-hr. per gallon of lubricating oil in this size of engine without running the used oil through a centrifugal separator. If the latter is done, considerable saving can be made.

It might be well to mention here a stunt that I have used on several jobs to obtain better wrist-pin lubrication. When overhauling an engine, the wrist-pin wipers, which are designed to pick up oil on the upward stroke of the piston, were grooved out on the lower side so as to pick up oil when traveling downward also.

I do not know, of course, how much oil they are using at the plant in question and can only hope that the above may give them some points upon which to base an investigation of their oil consumption troubles.

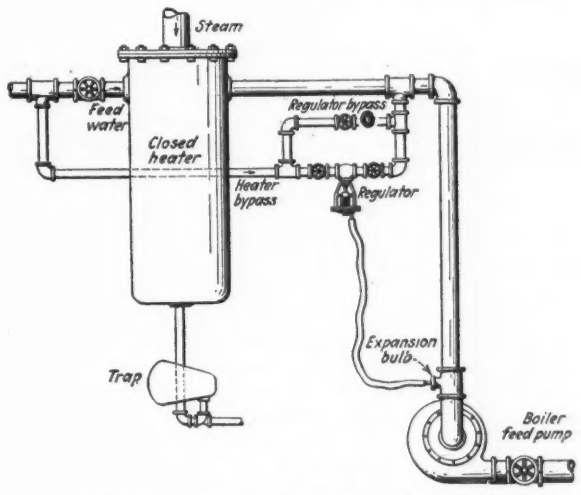
W. A. McKenzie,
C. C. Moore & Co., Engineers.

Seattle, Wash.

Control for Feed-Water Temperature

On page 106 of the Jan. 19, number of *Power*, a control for feed-water temperature was shown by H. M. Spring.

I would like to know why Mr. Spring goes to the trouble of heating part of the feed water even to the point of converting it to steam, only to cool it later by adding cold water. Certainly the temperature can be reduced by adding cold water, but why overheat in the first place? Would it not be simpler, and certainly more economical, to control the heat flowing to the heater? All that is necessary is a throttle or regulating valve in



The heater bypass arrangement under criticism

the steam supply line to the closed heater. This valve may work automatically, with the temperature of the feed water from the heater controlling it in the same manner as Mr. Spring controls his by-pass regulator.

The advantages of regulating the heat supplied to the closed heater over the by-pass method of regulating the feed-water temperature are lower first cost and lower radiation losses. The initial installation will be simpler, requiring three less valves and probably six less fittings. The radiation losses will be less due to the lower operating temperature of the closed heater. W. S. Hobbs.

Media, Pa.

READERS' PROBLEMS

PRESSURES OF CHLORINE—*In the Jan. 12 number of* POWER *there was a short article, "Preventing Temperature Effects On Chlorine Gas," in which it is stated that the temperature of a pump house increased the chlorine gas pressure from 75 to 150 lb.*

I have tried to calculate the temperature of the pump house necessary to cause such an increase in pressure, assuming the initial temperature of the gas as 60 deg. F. (520 deg. abs.), and using the general equation for relations between pressure and temperature of a volume

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

This method gives 493 deg. F. (953 deg. F. abs.) as the hot weather temperature of the pump house, which is real summer heat.

It is evident I have left out some important factor in my calculation, and I shall be glad if you will give a solution of the problem. E.R.S.

One cannot employ the equations applying to a perfect gas, in connection with chlorine. Chlorine is received in bottles and is a liquid. Above the liquid there will be some chlorine vapor whose pressure will depend upon the temperature of the surroundings. At 32 deg. F., this pressure will be 53.8 lb.; at 68 deg. F., the pressure will rise to 97 lb.; and at 104 deg. F. the pressure will be 169 lb., all values being absolute.

—◈—

ACIDITY IN OIL—*I Notice from time to time mention of acidity of turbine oil and this is always given in terms of KOH. Just what does this mean, and how is acidity determined?* C.P.M.

The acidity is measured in terms of the milligrams of potassium hydroxide (KOH) needed to neutralize a gram of the oil being tested.

To make the test accurately weigh 100 grams of the oil into a flask, add a solution of 25 c.c. of distilled water and 25 c.c. of 95 per cent alcohol which has been neutralized with weak caustic soda, and heat to the boiling point, using phenolphthalein as the indicator to determine when the solution is neutral. Agitate the flash thoroughly to dissolve the free fatty acids as completely as possible. Titrate while hot with aqueous tenth-normal alkali, free from carbonate, using phenolphthalein, alkali blue or tumeric as an indicator. Agitate thoroughly after each addition of alkali.

▼ ▼ ▼

Power Factor Correction Must Be Governed by Local Conditions

ON OUR power system the power factor is around 78 per cent. There is a possibility of replacing some of the larger induction motors with those of the synchronous type, but some doubt is expressed in our organization as to how much we should try to improve the power factor, if any. Will some of POWER'S *readers tell their experience correcting the power factor of their power systems, the benefits derived and the methods used to bring about the improvement?* O.R.

THERE is no standard power factor that is best for all plants to maintain. That is determined in every case by local conditions. The power factor of the system can be improved by the installation of synchronous motors, condensers or possibly the relocating of motors so they operate at or near their ratings instead of being partially loaded. But is the expenditure warranted?

Before making any changes or purchasing any equipment the situation should be carefully analyzed. The answers to the following questions will afford a ready decision and determine the proper course to follow:

1. What is the energy loss due to the present power factor of 0.78?
2. What is the annual cost of this energy?
3. Are you incurring a power factor penalty in a purchased power contract? Are you losing a bonus for high power factor in the same contract? If so, add these items to item 2.
4. Are any motors operating on low voltage? If so, will the improvement of the power factor increase the voltage to a satisfactory value?
5. Does the present power factor of 0.78 call for an increase in generating, switchboard or transformer capacity? If so, will the improved power factor make the additional capacity unnecessary?
6. If synchronous motors or condensers are decided upon will the power factor be improved where desired? That is, will the installation of this equipment better the power factor and the voltage on feeders that need the most urgent improvement? The new equipment will better the bus or generator power factor but possibly the power factor at those points is minor while the important factor is the bettering of the power factor and the voltage on some heavily loaded feeder.
7. Has a voltage and motor-load survey been made lately to determine the sources of the present power factor?
8. How long will it take to amortize the cash outlay for additional equipment or changes based on the savings to be made in energy losses, penalty and bonus clauses and better operation?

If these questions are carefully answered the logical method of procedure will be evident.

The writer knows of a case in which the betterment of a power factor of 80 was uneconomical while in another case it was economical to improve a power factor of 90. Each case must be determined by its own merits.

VICTOR N. FRIEDMAN.

St. Louis, Mo.

—◈—

AS AN EXAMPLE, an actual case is modified slightly to correspond as nearly as possible to O.R.'s condition. In a plant operating with a demand load of about 400 hp. in induction motors a 60-hp. motor was to be installed on what would be a steady full load. The power factor was to be maintained above that where a penalty became effective, 85 per cent. If an induction motor were used, running fully loaded, its power factor would be in the neighborhood of 85 per cent, but its effect on the plant's power factor would be to raise it only about one point. If a synchronous motor were installed the plant's power factor could be increased to over 85 per cent, the desired figure, when the motor was operating at 80 per cent power factor leading.

On the basis of the rate schedule in effect and a 78 per cent power factor the monthly energy charge would be $619.50. If the power factor were corrected to 85 per cent the monthly energy charge would be $592.50, a saving of $27, or $324 annually.

The cost of an induction motor, with starting equipment, was $705. For a synchronous motor to operate at 80 per cent leading power factor the cost was $1,201 with manual starting equipment; allowing for slightly higher installation cost, say, $1,250, or $545 more than the induction motor. In this particular case, therefore, the synchronous

KILOVOLT-AMPERES REQUIRED TO CORRECT POWER FACTOR

Power Factor Corrected From Per Cent	Corrective Kva. Required Per 100 Kw.
78 to 85	18.1
78 to 90	32.2
78 to 95	47.7
78 to 100	80.5

motor would be a paying proposition. The annual fixed charge at 12 per cent on its added cost is $65.40 against an annual saving of $324. If an induction motor were used with a static condenser for power factor correction, the cost of the static condenser alone would be about $1,200.

There is also to be considered the saving due to decreased copper loss, the reduced voltage drop, the increase in capacity of lines and transformers as a result of improved power factor. In this case if the lines were fully loaded at 78 per cent power factor, increasing the power factor to 85 per cent would allow 9 per cent additional load to be carried.

It usually does not pay to increase power factor much above 85 per cent, the cost of the corrective equipment becoming excessive. The table shows the corrective kilovolt-ampere capacity necessary to correct a load of 100 kw. from 78 per cent to various percentages, and the corrective kilovolt-amperes required.

M. S. MACGILLIVRAY.

Montreal, Que.

—❖—

WHILE a power factor of 78 per cent is not considered low, there is room for improvement. A few years ago the power factor of our system averaged 68 per cent, which was improved only about 2 per cent by carefully checking each motor and changing them, where possible, so that they operated as close to full load as was practicable.

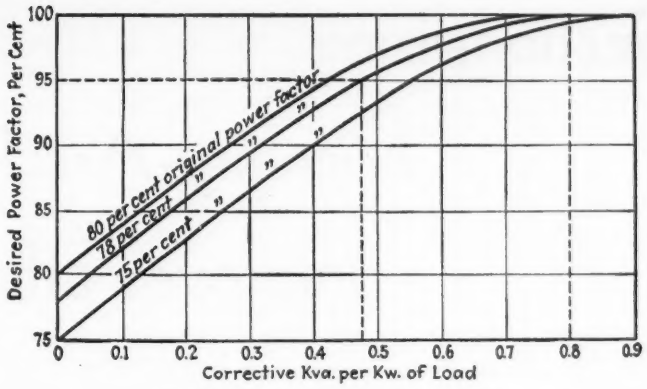
Due to constantly increasing load, a time arrived when our generators, rated at 80 per cent power factor were overloaded. It was necessary, therefore, to either provide more generating capacity or improve the power factor, and utilize what we had more efficiently. After considering the use of synchronous motor drives or static condensers, it was decided to install a 180-kva. capacitor in the engine room. This was done, and the effect was immediately apparent not only on the generators and exciters, but all over the plant, in improved voltage regulation. The capacitor increased the power factor at the generating end of the system to around 82 per cent, and provided some excess generating capacity over the load at that time.

By the following year the load had increased so that it was again necessary to consider more generating capacity. As some of the distribution lines were carrying an overload, it was decided that static condenser units at the load centers would not only increase the generating and line capacity, but also reduce the line loss. A 60-kva. unit was installed near the end and close to a load center, on each of three lines, and one 10-kva. unit on one elevator motor. This brought the power factor up to about 90 per cent, and proved to be a profitable step. The capacity of the generators was increased a substantial amount, to which was added the saving in power due to the decreased line loss. The combined increase in generator capacity and saving in power has enable us to get along to the present time without any further changed.

ELMER N. ANDERSON.

Austin, Minn.

—❖—



Reactive kilovolt-amperes required to correct power factor

THE CURVES show the corrective leading kilovolt-amperes per kilowatt of load required to give any desired power factor. To improve the power factor of O.R.'s load from 78 to 100 per cent will require 0.8 leading reactive kilovolt-amperes per kilowatt of load, while to give 95 per cent power factor requires only 0.475 reactive kilovolt-amperes, as indicated by the dotted lines. Obviously, it will be more profitable to improve the power factor to about 95 per cent instead of unity. The reactive kilovolt-amperes load can be supplied in three general ways, all of which are now being used successfully by our customers:

1. Rearrangement of existing induction motors and use of synchronous units on large continuous drives.
2. Static condensers (capacitors).
3. Synchronous condensers.

There are instances on our system where several per cent increase of plant power factor was obtained by a check of existing induction motor loads, the motor sizes being adjusted as nearly as possible to the load carried. This will not improve the average power factor much above 85 per cent.

Should there be several large continuous drives in the plant, 0.8 power factor synchronous motors could be installed. For instance, a 100-hp. 0.8 power factor synchronous motor driving 100 per cent rated load will supply 62 leading reactive kva. to the system. A synchronous motor of this type and size will cost about $250 more than the induction type. One large plant with a connected induction motor load of 1,100 hp. uses 75- and 100-hp. synchronous motors on two fans. These operate continuously, and give an average power factor of 90 per cent. Due to the power factor clause in the rates, these synchronous motors save the customer about $200 per month.

Capacitors can be used profitably to correct poor power factor for requirements up to about 1,000 kva. Their cost is relatively constant, all sizes averaging about $20 to $22 per kva. Static condensers possess the advantages of negligible operating cost and maintenance, ease of installation, and readily adapted in small units at load centers in the plant. One plant in our territory recently installed a 90-kva. capacitor to improve the power factor from 60 to 95 per cent. A saving of $140 per month on the power bill was the result.

Synchronous condensers are used most profitably in sizes above 1,000 kva., and in conjunction with very large industrial plants or utility systems. A 5,000-kva., 600-volt synchronous condenser will cost approximately $7.50 per kva., complete with control equipment. On smaller sizes the unit cost increases rapidly, so that some other form of corrective equipment is generally more economical.

Some plants use both static condensers and synchronous motors to improve power factor. With this scheme the motors are selected to give as much correction as they can, without becoming too large for their load, and capacitors are used to supply the remaining corrective kilovolt-amperes.

E. E. MACCORKLE, JR.,
Power Engineer,
Kentucky & West Virginia Power Co.
Ashland, Ky.

▼

A Question for Our Readers

WHEN A COIL fails in a three-phase induction motor's winding can the coil be cut out of circuit and the winding closed as in a direct-current armature? If a coil is cut out of one phase will it be advisable to cut a similarly located coil out of the other two windings? If coils can be cut out of the winding how many can be eliminated before the motor operation will be affected adversely?

E.H.C.

Sutable answers, if received promptly, will be paid for when published

Sectionalizing Mercury-Arc Rectifiers Improves Efficiency*

SECTIONAL - TYPE mercury arc rectifier is based on the principle that the smaller sizes are more efficient, reliable, economical and flexible than large units. Subdivision into unit sections introduces both advantages and disadvantages, but the former outweigh the latter. When the size of mercury-arc rectifiers is increased to obtain larger capacity, however, the quality decreases markedly. Reliability decreases as the size is increased. The outage time per year with 3,000-kw. rectifiers is several times as great as with 500-kw. units. Cost per unit of output does not decrease with increase of size, as it does with some apparatus, because manufacturing problems increase faster than in proportion to size. Efficiency falls off with increase in size because of the longer arc and greater exposure to deionizing surfaces, and because of an increase in loss-producing devices to get acceptable quality. With present designs, the internal losses for a 500-kw. unit are approximately 25 per cent less than for a 3,000-kw. unit, both based on 600-volt operation.

*Abstract of a paper, "High-Capacity Rectifier Efficiency Improved by Sectionalizing," by A. L. Atherton, Westinghouse Electric & Manufacturing Company, presented at the winter convention of the American Institute of Electrical Engineers, held in New York City, Jan. 25 to 29, 1932.

The major disadvantages associated with size appear to be fundamental and permanent, whatever advances may be made in the art. Larger units will apparently always be less efficient, and the reliability and cost disadvantages will probably persist.

Our work with rectifiers of conventional size and characteristics has resulted in the conviction that the limits of capacity for a given design, as for example the 500-kw. unit shown in Fig. 1, lies in local limitations of the various parts. For example, conductivity and heating at the anode limits the capacity and not the tendency to arc back at the higher currents. The 500-kw. 600-volt unit carries a nominal current of 833 amp. continuously, 1,250 amp. for two hours, and 2,500 amp. for one minute. In all our testing, which includes currents up to 17,000 amp. on short circuit we have not experienced arcing back as a limitation. Extended service experience with a limited number of installations gives the same result.

Rearrangement of parts made possible a reduction in size for a given rating, and at the same time brought about some reduction in the internal losses. The rearrangement was based on the knowledge gained experimentally of the way the vapor flows from the cathode to the condensing wall and the position of the anode structures in relation to this stream of ionized vapor. Although the whole mechanism of vapor flow and its effect on arcing back are far from known, several factors which influence performance have been established. The design shown in Figs. 2 and 3 is an attempt to take these somewhat uncertain factors into account in the most satisfactory way at the present time.

The anode support and shielding arrangement also offered an opportunity for progress and an extended series of experiments resulted finally in the anode structure shown. Processing to eliminate foreign material and keep the gas evolution under operation at as low a value as possible, have progressed along with the design development. As a result of these improvements, the rectifier shown in Fig. 2 is capable of a standard nominal rating of 750 kw. at 600 volts, and even of higher short time overloads as sometimes required.

At 750-kw., 600-volt rating the rectifier is required to carry a normal current of 1,250 amp. and 50 per cent overload, 1,875 amp. for two hours. Because final temperatures are reached in about two hours, it is felt that the two-hour capacity can best be indicated by continuous operation at the 50 per cent value. Double load, or 2,500 amp. is required by standard nominal rating for a period of one minute following full load. Experimental tests have been made at this current up to 5 min. duration.

In all these operations, arcing back is infrequent if it occurs at all and it is a requirement that the rectifier can be put into operation again immediately following such an occurrence.

The internal losses in the rectifier are determined by the arc drop, or voltage from anode to cathode during the conducting period. This value varies with load current and can be indicated by a curve of voltage drop against load current. The value that determines efficiency is the average for the various

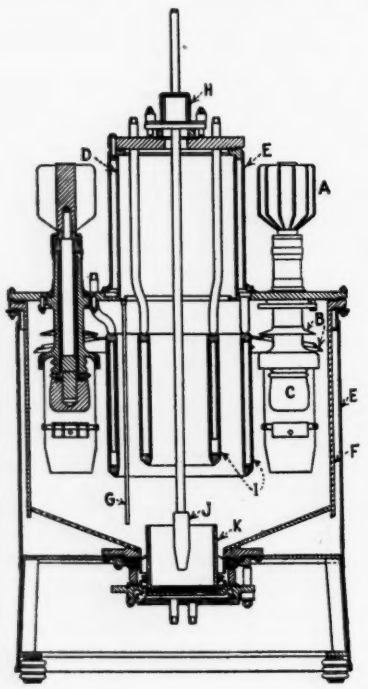


Fig. 1 — Cross-section through a 500-kw. 600-volt rectifier, which is 54 in. in diameter and 104 in. high

A—Anode radiator; *B*—Vapor baffles; *C*—Anode; *D*—Condenser dome; *E*—Water jacket; *F*—Tank; *G*—Mercury-return tube; *H*—Starting-electrode solenoid; *I*—Ring coolers; *J*—Starting and exciting electrode; *K*—Mercury pot.

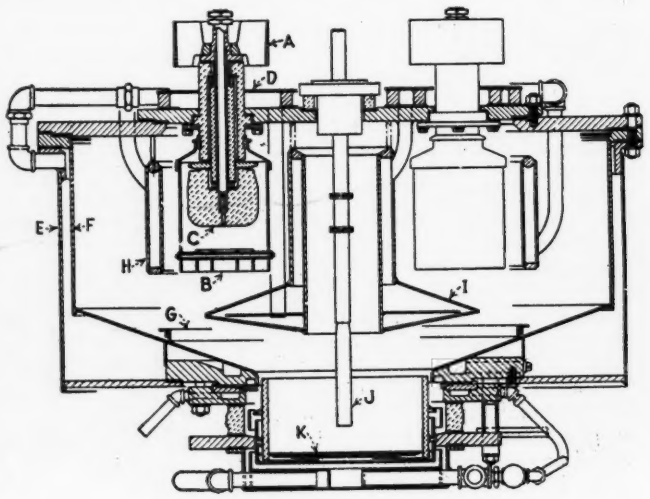


Fig. 2 — Section through new type 750-kw. 600-volt rectifier, which is 54 in. in diameter and 41.5 in. high

A—Anode radiator; *B*—Anode grid; *C*—Anode head; D—Anode water jacket; *E*—Outer tank; *F*—Inner tank; *G*—Mercury-sediment trap; *H*—Outer ring cooler; *I*—Inner ring ooler; *J*—Starting-anode head; *K*—Cathode mercury pool.

anodes. Fig. 4 shows average arc drop curve for different type units. The dotted curve shows the value for the older type unit, Fig. 1. As the size of a rectifier is increased, the arc path becomes longer and losses per kilowatt output become greater. Experimental rectifiers of 3,000 kw. with a single tank have had arc-drop values shown by the dot and dash curve of Fig. 4. It is seen that at full loads the difference between these experimental single-tank 3,000-kw. rectifiers and the one in Figs. 2 and 3 amounts at full load to approximately 6 volts or 1 per cent, on the basis of 600-volts output. With ordinary load factors and rates for power, this difference in 3,000-kw. rating saves from $600 to $1,500 per year power cost, which represents an added value of from $4,000 to $10,000.

The proportions of the new unit are such as to make it feasible to mount them in service one above another. Thus, a 3,000 kw. unit can be made of four 750-kw. sections mounted two side by side and two deep, as in Fig. 3.

The floor space required for such an assembly is approximately 118 in. wide, by 68 in. deep over all parts, including auxiliary equipment and the overall height is 113 in. Such an arrangement is likely to prove the most convenient for usual applications. There is no reason why other arrangements cannot be used where available space places a limitation on one or more dimensions.

The problem of paralleling the different units is the same as for single-tank rectifiers using the same number of anodes. Load balancing is inherently approximately correct due to the voltage across the arc rising with increasing current after a minimum of about 40 per cent load is passed. To get a closer balance, anode balancing coils are used and these are so arranged as to introduce no appreciable impedance into the circuit under normal operation. If it is desired to take a section out of service, for any reason, the corresponding balancing coil sections are short circuited by connection links.

Two independent pumping systems are used connected through a manifold to the various sections. Cross connections are so arranged that either pumping system can be used on any or all of the tanks. The various sections of the rectifier are connected to the vacuum manifold through two valves of unique design, provided with a sealing plate as an extra precaution against outside air. Even if such a valve should develop a leak, this safeguard would prevent any leakage into the tanks except at a very slow rate and for the minute or less while the valve position is being changed. Using two valves permits separating a single section from the structure without admitting air to either part. If maintenance work is to be done it is possible to put the repaired section in condition by pretreatment. After this treatment, the section is installed and by proper manipulation of the valves is exhausted completely without admitting air to it or any part of the operating system.

Sectionalizing inherently provides that any damage which occurs is likely to be limited to a relatively small part of the total structure and that the load can be carried during the period of maintenance with the balance of the structure. With the arrangement Fig. 3, a faulty section is segregated from the others by removing the connection links and closing the valves, requiring only a few minutes, before load can again be carried. Although a maintenance operation is required to remove a unit from the structure for repairs requiring two hours or so this can be done during a light or no load period.

It would be possible to arrange with jack connections and separate systems of auxiliary equipment or flexible pumping and water connections so that the operator could pull the unit forward a few inches and continue operation with the balance of the equipment after an interruption of one or two minutes. The choice between these two plans depends on the frequency with which interruptions are likely to occur. Experience thus far indicates that interruptions requiring maintenance will be so infrequent as to make the simpler plan preferable.

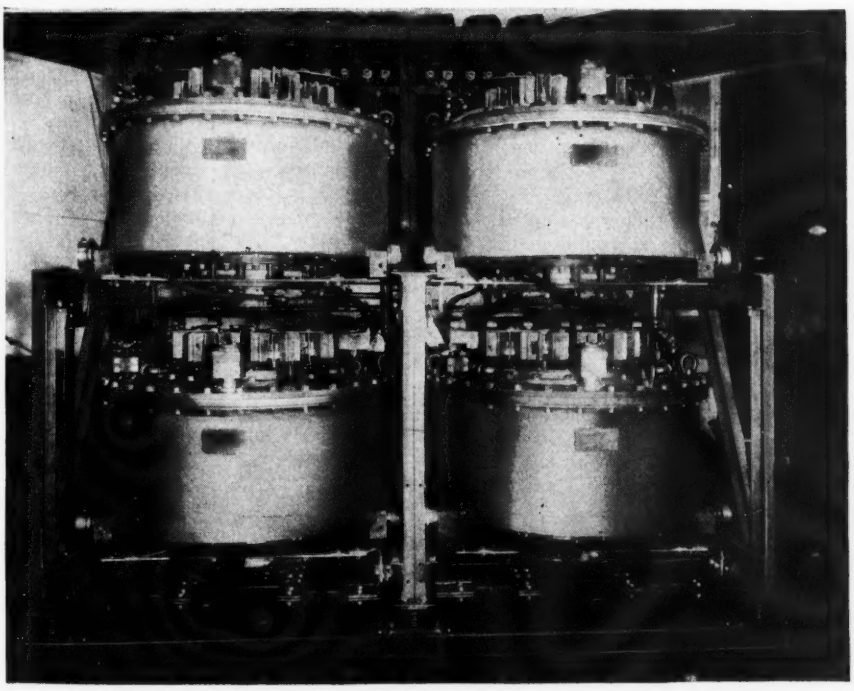


Fig. 3—Sectionalized rectifier of 3,000-kw., 600-volt rating consisting of four 750-kw. sections

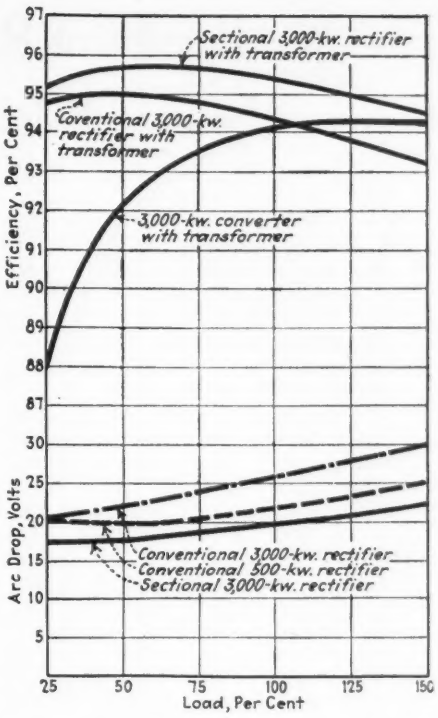


Fig. 4—Characteristic curves for conventional and sectionalized-type rectifiers

Differences of opinion were expressed, in the discussion on this paper, regarding the reliability of large and small rectifiers and Mr. Atherton's statement that there are fundamental limitations to the size of large units of the conventional type. Some speakers claimed that the multiplicity of parts in a rectifier made up of sectional units would subject it to more frequent interruptions and others pointed out that a failure of any unit would merely reduce the capacity of the bank, whereas failure of a large unit would cause outage of its entire capacity. Dr. A. W. Hull, General Electric Company, contended that no scientific investigation has proved that there is any limitation to single-unit rectifiers up to 9,000 kw. at 600 volts. Dr. Joseph Slepian, Westinghouse Electric & Manufacturing Company, said emphasis of the sectional feature had apparently made people overlook the improvement made compared with units of comparable size. When more is known about the conductivity of vapors and the cause of back-fires, some radical improvements can be made in rectifiers, which now fall far short of the ideal which might be expected from a purely scientific viewpoint.

Results of Research on Cyclone Dust Collectors Presented Before A.S.M.E. Metropolitan Section

AT A MEETING of the Fuels Division of the Metropolitan Section of the A.S.M.E. on Feb. 18 Louis C. Whiton, Jr., president of the Prat-Daniel Corporation, presented a paper giving the results of an extensive investigation of cyclone characteristics instituted by his organization.

As a result of the research information was obtained from which a number of conclusions of significance to cyclone users can be set forth.

Part of the investigation was carried out through the courtesy of the Brooklyn Polytechnic Institute. Part was done at the company's New Rochelle plant; and part by the research division of the associated French Company. Correlation of these several researches makes it possible to present conclusions on the following points: effect on collection of, collector diameter; collection velocity; collection temperatures; mesh of dust; grain loading; arrangement of outlet pipe at the bottom of the cyclone; and rate of emptying the cyclone. Some data were also obtained on the distribution of pressure within an operating cyclone.

Three Different Sizes of Cyclones Tested

The testing equipment consisted of the following: A gas-heated brick furnace constructed for producing the necessary heated gas when testing cyclones at temperatures higher than atmospheric. Between the furnace and the fan was an inlet hopper for the introduction of the dust. A duct then passed to the inlet of the 1 ft., 2 ft., and 3 ft. diameter cyclones. The outlets of the cyclones were connected to a 15-ft. straight run of pipe, 17¾ in. in diameter at the beginning of which vanes were placed so as to avoid a whirling of the gas through the pipe. Pitot-tube readings were taken at five places in this pipe. The end of the pipe was connected with a Canton-flannel bag 21 ft. long and 74 in. in circumference.

Each type of cyclone from the standpoint of diameter, was capable of being increased or decreased in height so as to obtain six different shaped cyclones. Each of the cyclones was also equipped with several outlet collars which could be placed at any desired position below the top of the cyclone, and each cyclone had several bottom cones. This permitted 108 proportions of cyclone design for each diameter.

The determination of efficiency was made by introducing a known weight of dust into the system and measuring the quantity of dust caught which was checked against the quantity of dust in the cloth bag.

The materials tested covered a large variety, ranging from fly ash, obtained from electrical precipitators, Fullers earth of various meshes, cement kiln dust, gray cement, and a variety of industrial products. For purposes of comparison the fly ash from the pulverized-fuel installation was taken as the standard material in the tests.

Tests as to the fineness of the dust were made in a Ro-tap testing apparatus and in all cases, the dust was dried beforehand so as to have a uniform moisture content.

Effect of Diameter of Cyclone

The effect of diameter of cyclone on collection was also studied. This was done to determine the economic point from a commercial standpoint of various diameters of cyclones, since, theoretically, the smaller the cyclone, the higher the collection efficiency, but the higher the draft loss through the cyclone and the greater the initial cost of investment.

In these tests, the dust was contained in air at 80 deg. F. and careful determinations were made by means of Pitot tubes placed in the outlet straight run of ducts to determine the number of cubic feet per minute passing through each cyclone at various draft losses.

Fig. 2 shows a series of curves indicating the capacity of cyclone and the efficiency of collection on the same material at varying draft losses with the 1 ft., 2 ft., and 3 ft. diameter cyclones of symmetrical design, the dotted portion of the curves being extrapolations. It will be noted from this curve that an optimum point is reached where the curve starts to flatten out and no important increase in collection occurred above this point.

With the 1-ft. cyclone, this optimum point is not reached until about 5.5 in. w.g. With the 2-ft. cyclone, the optimum point is reached at 2 in. w.g. The 3-ft. cyclone reaches its optimum point at approximately 1.5 in. w.g.

Therefore, it is evident that, if for practical reasons, it is assumed that the cyclone collector should operate at approximately 1.25 in. w.g. draft loss, the best collection will be obtained with the 2-ft. cyclone in preference to either the 1-ft. or the 3-ft. size.

The draft loss diminishes more rapidly than the corresponding reduction of gas volume, although it does not drop as the square. With low draft loss the collection efficiency likewise drops rapidly, as shown by the curves Fig. 2.

This fact would have considerable importance in the collection of fly ash from boiler flue gas, due to the fact that there is usually considerable variation in boiler rating and the collecting apparatus should be designed for maximum rating, which would produce maximum dust loading in the gas and maximum gas quantity. Hence it would appear advantageous to control a series of small cyclones in parallel so that with half the quantity of gas, only half the cyclones would be in operation, thereby maintaining the design conditions as to resistance and gas quantity per cyclone.

The foregoing figures are on a particular pulverized-fuel dust and are of value for comparison. Fineness of dust, temperature of gas, and real specific gravity of the particles will affect the collection at different draft losses.

Preliminary research indicated that collection was higher with cold gas than with hot gas and this was justified by a study of Stokes law relating to the fall of a particle of dust through a layer of gas at different temperatures. This law is as follows:

$$F = 6\pi R\eta V$$

where F is the resistance of the fluid
R the radius of the particle which is assumed to be spherical
η being the coefficient of viscosity of the fluid
V the speed of the particle in relation to the fluid

From this law it will be seen that the force which must be exerted upon a particle to force it through a fluid is directly proportional to the viscosity of the fluid.

Although the density of hot gas is less than the density of cold gas, the viscosity is considerably more, air being 1.24 greater at 212 deg. F. than at 32 deg. F. and 1.44 greater at 392 deg. F. than at 32 deg. F.

From the foregoing it will be seen that the centrifugal force which must be exerted upon a particle in a cyclone must be greater at higher temperatures than at lower temperatures to carry it to the wall of the cyclone in a given period of time. The results upon collection, of increasing the temperature, when using a 2-ft. cyclone, are shown in Fig. 3. From this it will be seen that the recovery efficiency drops approximately 2 per cent for each 100 deg. F. rise in temperature with a constant pressure loss.

In the actual test run, temperatures over 300 deg. F. could not be used because of the danger of destroying the cloth bag at the outlet. The curves for 400 deg. and 500 deg. are therefore extrapolated and have since proved approximately correct in actual practice.

Effect of Mesh of Dust on Collection

Since in most cases, from a commercial standpoint, it is not possible to determine the screen analysis of the dust that it is desired to collect before the installation is put in operation, it was desirable to determine the precise collection, for example, of dust which remained upon 100 mesh, dust which

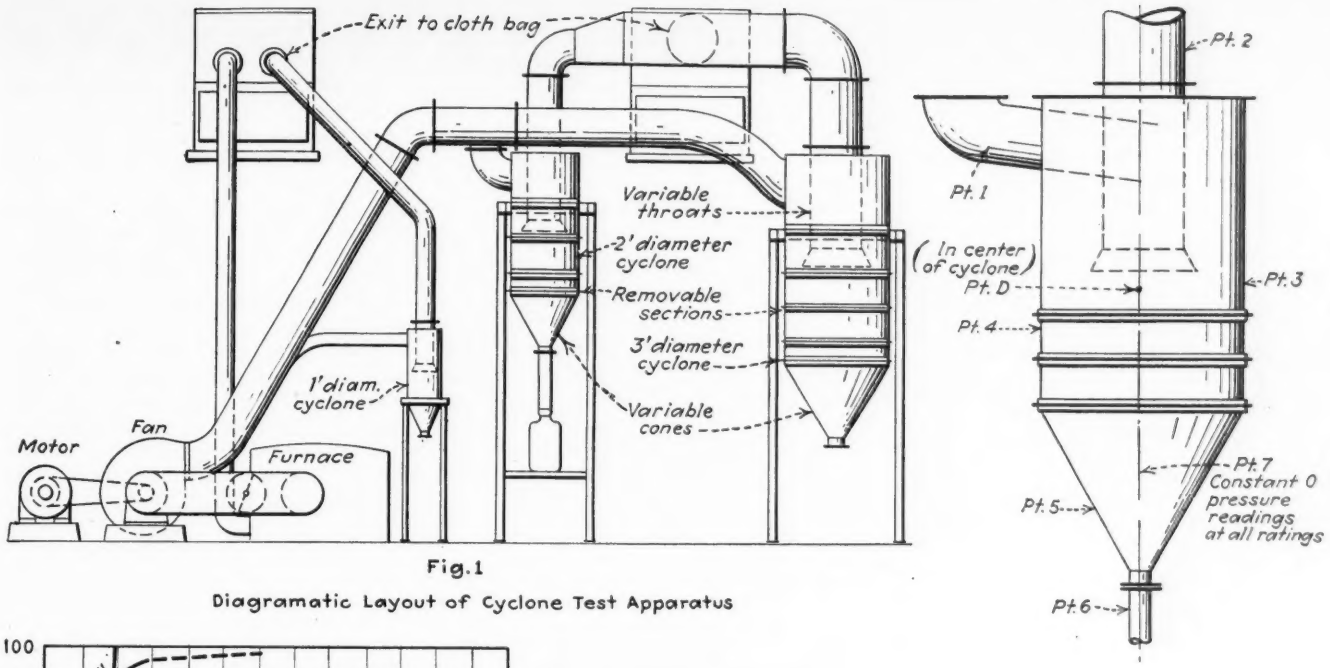


Fig. 1

Diagramatic Layout of Cyclone Test Apparatus

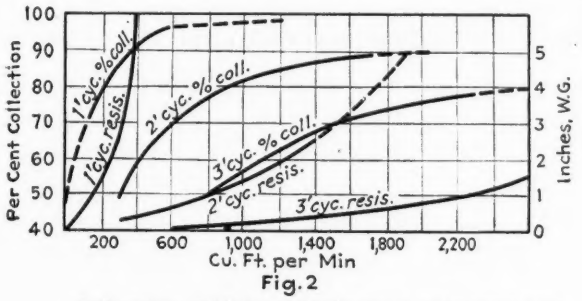


Fig. 2

Collection Efficiency, Resistance and Capacity of 1 Ft., 2 Ft., and 3 Ft. Diam. Cyclones at 80° F.

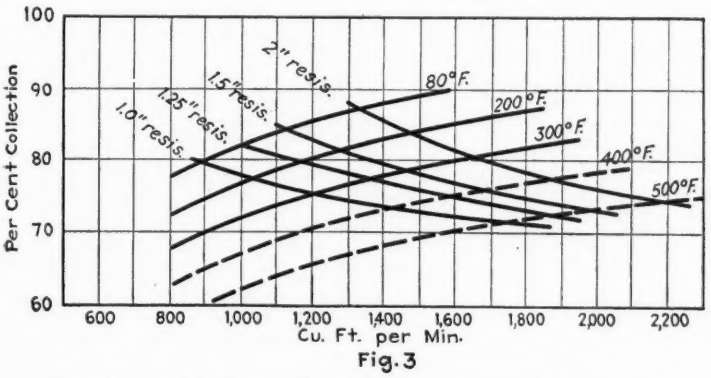


Fig. 3

Collection Efficiency, Resistance and Capacity of 2 Ft. Diam. Cyclone at Varying Temperature

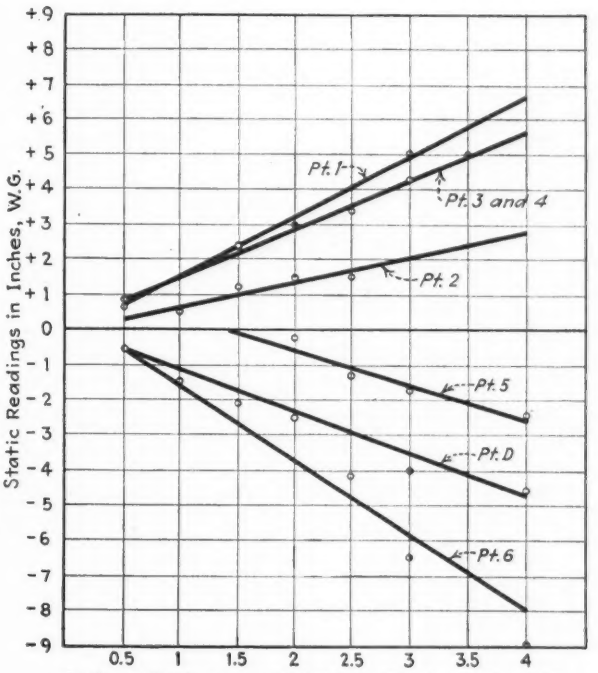


Fig. 6

Static Readings Within Cyclone

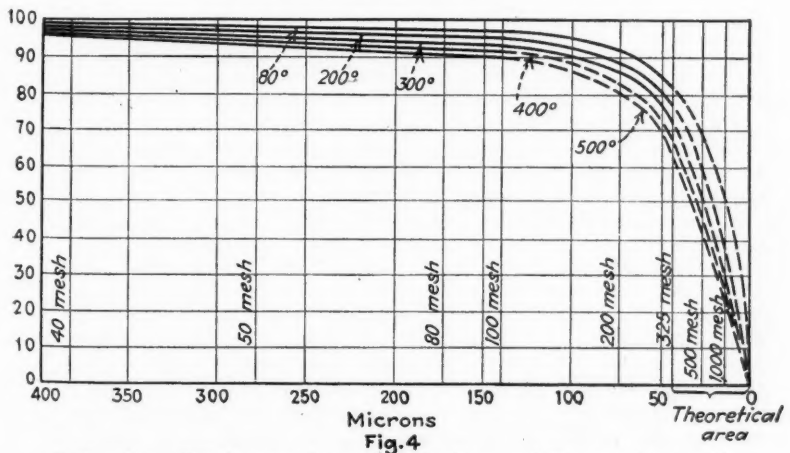


Fig. 4

Collection Efficiency According to Size and Temperature with a 2 Ft. Diam. Cyclone Handling 1,000 Cu. Ft. per Min.

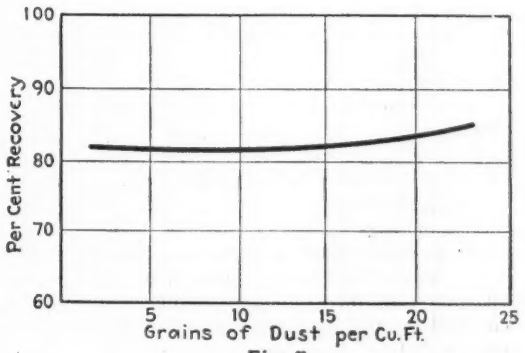


Fig. 5

Per Cent Recovery of Fly Ash in 2 Ft. Diam. Cyclone Handling 1,000 c.f.m. 80°F.

passed through 100 mesh but remained on 200 mesh, and dust which passed through 200 mesh and remained on 325 mesh. The collection of dust passing through 325 mesh was evidently varied, depending upon the ultimate fineness of the dust, and no precise results could be anticipated which would cover the entire field of dust.

Since the finest screen which can be obtained commercially at the present time is 325 mesh with an opening of 43 microns, all dust which will pass through this mesh screen is of an unknown fineness. Scientific predictions as to collection of the amount of dust, finer than 325 mesh, therefore, cannot be given. Except by microscopic examination upon relatively few particles, which is inexact for the whole, there is no satisfactory way for determining precisely the average fineness of the dust passing through the finest mesh screen.

In this series of determinations a large quantity of dust was run through the Ro-tap so as to classify it in material coarser than 100 mesh, through 100 and on 200 mesh and through 200 and on 325 mesh.

Constant pressure differential and flow of air through the cyclone was maintained for the various meshes. From the large number of results obtained, the curve, shown in Fig. 4, was devised for this particular cyclone using the pulverized-fuel fly ash employed in the test.

The curve is arranged according to the diameter of the particles in microns and the screen sizes given are those corresponding to the U. S. Bureau of Standards.

The following observations are pertinent. The size of the opening or diameter of the particle decreases approximately inversely as the size screen mesh, as indicated in the table:

U. S. Standard Screen Size	U. S. Standard in Microns
50	279
100	140
150	104
200	74
250	61
300	46
325	43

On this same basis the size of particles can be calculated, which would pass through theoretical 400, 500, 600 and finer meshes, which are too fine to construct. There would be approximately as given in the table:

Theoretical Screen Size	Theoretical Micron Size
400	34
500	27
600	23
700	19
800	17
900	15
1000	13.6

The curves in Fig. 4 must necessarily all reach zero collection before or at zero diameter and the dotted lines shown beyond 325 mesh or 43 microns are estimations only. However, it serves to give some idea of the expected collection of 27-micron material (theoretically 500 mesh) and 13.6-micron material (theoretically 1,000 mesh). In the former case this would appear approximately 70 per cent collection at 80 deg. F. and in the latter case 50 per cent collection. Furthermore by this curve an exact prediction can be given for dust larger than 325 mesh if the granularmetric analysis is obtainable beforehand concerning the collection of similar dust in a similar cyclone.

The curve Fig. 5 indicates that within the usual limits of grain loading ranging from 1 to 22 per cubic foot, there is practically no difference. The slight rise for higher grain loadings is probably due to the fact that at these loadings some of the dust does not strike the cyclone walls proper, but is cushioned by other particles and thus is not subjected to as much breakage and since breakage has a tendency to create a greater amount of fines, the less the breakage, the greater will be the amount of collection.

Various shapes were designed for the outlet pipe which carried the dust away from the cyclone. It was found that an increase in diameter of the pipe at the outlet of the cyclone had an advantage over a straight pipe. It was also found that it is an advantage to evacuate the dust as rapidly as possible from the bottom of the cyclone by means of proper containers and a properly designed outlet pipe.

Tests were also made to determine the relative pressures within the cyclone when handling various quantities of gas. The static portion of a Pitot tube was used to determine the static pressures at various points. The results of these tests are clearly shown by the curves in Fig. 6.

▼ ▼ ▼

Three Cheers for "Automobileium"

TO ENGINEERS of inquiring mind A. W. Frehse of the Chevrolet organization offers the life and other history of a remarkable new metal. Readers are urgently requested not to write in for further information. Mr. Frehse, without apology to Will Rogers, reports:

"This metal was discovered by means of the spectroscope on the asteroid Xerxes by a young astro-physicist. The absorption lines showed remarkable characteristics inasmuch as the images of the slit become parabolic curves. The astro-physicist maintained great secrecy with his discovery, and one day recently had the great good fortune to discover the metal in his laboratory from samples he found in the State of Connecticut.

"By further prospecting during his summer vacations, he found the metal to exist in enormous quantities in the same state, and after reducing it from the ore, the process of which is extremely simple but closely guarded, he proceeded to examine its physical properties. These he found to be extraordinary, in fact so remarkable that he decided to call the new metal "Automobileium," because it at least completely covered the automobile engineers' specifications of an ideal material with which to design and manufacture all automotive apparatus. The material is now available in great quantities at a cost somewhat lower than that of iron.

"The physical properties of the metal now offered for use are:

Weight—about the same as magnesium.

Color—pale blue.

Melting point—this can be varied to suit conditions.

Coefficient of expansion—slightly less than Invar.

Modulus of elasticity—1,000,000,000.

Ductility—exceeds that of platinum.

Electrical conductivity — slightly greater than silver.

Hardness — a little harder than Stellite.

Machineablity—about the same as butter as 72 deg. F.

"The metal requires no lubrication because it refuses to rub elbows with the commoner metals. In fact it exceeds by far in all characteristics the qualities of ferro-*manureium* used so extensively in practice today.

"Its chemical symbol is B.S."

56,800 -Hp. Diesel Plant Installed on "Deutschland"

THE "DEUTSCHLAND" will be the first armored ship of considerable tonnage to be propelled entirely by internal combustion engines, and full details of her machinery are now available. It comprises eight compressorless, double-acting, two-stroke, M.A.N. Diesel engines, each set of four engines driving a single propeller shaft through a Vulkan hydraulic gear. Each of the nine working cylinders of an engine unit has a diameter of 420 mm. (16.55 in.) and a piston stroke of 580 mm. (22.85 in.). At full power, 450 r.p.m., the plant develops 56,800 hp. and when allowance has been made for loss of power through the hydraulic coupling and the gears it is estimated that 54,000 hp. will be transmitted to the propellers. It should be added that the Vulkan gear reduces the speed of the shafts to 250 r.p.m. The entire installation is unique in the power developed proportionate to its weight. At the same time the original claim that a unit of horsepower was generated for every 17½ lb. of weight is now shown to be misleading. The gross weight works out at 45½ lb. per horsepower.—*The Engineer.*

THE ENGINEER'S BOOKSHELF

Managing Plant Personnel

POWER PLANT MANAGEMENT. *By Walter N. Polakov, consulting engineer. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 1932. Cloth, 5x7½ in.; 176 pages, 28 illustrations. Price, $2.*

BASED ON more than twenty years' experience in the field, this book fills a gap in management literature by offering a set of long-tested practical references, telling how to organize the human side of work in the power house. The book shows how to investigate the economic and engineering soundness of the power plant organization, gives much information on the allocation of duties, practical details of management that may be adopted without confusion or expense and supplies actual case accounts to show results of the adoption of these methods.

The contents of the book includes much of the material contained in a series of articles by Mr. Polakov, which ran in *Power* from May 14 to Dec. 3, 1929. Starting with executive functions, it takes up in order the duties of the plant superintendent, chief operating engineer, watch engineer, head fireman, power plant clerk, power record man, steam and power dispatcher and maintenance man. Succeeding chapters deal with work schedule charts, repair records, inspection and care of instruments, fuel utilization charts, time keeping, substores, idle expense record, power expense classification, task work with bonus, tickler and betterment recommendations.

In the appendix several cases from actual practice are described under the titles: "Task Work With Bonus in a Central Station," "Permanence of Improvement in a Small-Size Plant," "Distribution and Utilization of Steam and Power" and "Economy Plus Employee Satisfaction in a Small Plant."

Smithsonian Report

ANNUAL REPORT OF THE BOARD OF REGENTS OF THE SMITHSONIAN INSTITUTION, 1930. *Published by the United States Government Printing Office, Washington, D. C.; 1931. Cloth, 6x9 in.; 650 pages, illustrated. For sale by the Superintenddent of Documents, Washington, D. C. Price, $2.*

THE SMITHSONIAN INSTITUTION is concerned with such a wide group of sciences and arts that no one would expect to be deeply interested in every part of one of its annual reports. Yet, because of this very breadth, one can be sure of finding something of interest in each of these yearly volumes.

The present report follows closely the general make-up of its predecessors. Approximately one-quarter is a brief account of the condition of and progress made by the Institution and its associated activities. The remaining space, some 500 pages, is made up of selected articles, some original and some reprinted, giving the reader an idea of recent accomplishments in such fields of endeavor as astronomy, physics, chemistry, geology, archeology, ethnology, entomology, aviation and engineering.

Of outstanding interest to the engineer is the account, made up of extracts from two sources, of the design and construction of the Holland vehicular tunnel under the Hudson River. Ventilation is, of course, the most important feature of this tunnel, and the article, by diagram and text, briefly but clearly shows how the designers have solved this problem.

The other articles in the report are of equal interest to those who will read them, serving particularly to keep the layman of the sciences discussed up to date.

Reviewed by G. L. MONTGOMERY.

Heating and Ventilation

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS GUIDE, 1932. *Compiled and published by the A.S.H.V.E., 51 Madison Ave., New York City; 1932. Leatherette, 6x9 in.; 940 pages; illustrations, charts and tables. Price, $5.*

AS IN PREVIOUS YEARS, the 1932 edition of the "Guide" contains four major sections; namely, text section, manufacturers catalog data section, index to modern equipment and membership roll of the American Society of Heating and Ventilating Engineers.

The text section contains 40 chapters, five more than last year's "Guide." The additional chapters are due to a complete rearrangement of the material and to the inclusion of such subjects as smoke, dust and cinder abatement. Practically every chapter has been rewritten and considerable new material has been added, so that it contains the results of the most recent research findings.

The data included in this and past editions of the "Guide" make it a handbook of value to heating and ventilating engineers.

Chemical and Physical Data

HANDBOOK OF CHEMISTRY AND PHYSICS. *16th Edition. By C. D. Hodgivan and N. A. Lange. Published by the Chemical Rubber Publishing Company, West 112th St. and Locust Ave., Cleveland, Ohio; 1931. Cloth, 4½x6½ in.; 1,545 pages. Price $5.*

AS A REFERENCE WORK for chemists, physicists and others in special engineering branches this volume will be exceedingly valuable. For the mechanical engineer its chief value is the collection of tables on materials, many of these being absent from most handbooks.

Sixteen pages of tables on acceleration due to gravity, latitude, longitude and elevation entirely replace two pages on the same subject in former editions. The new table gives this information for important places in every country in the world instead of just a few of the largest cities.

A very valuable addition is the eleven pages of new matter entitled "Abbreviations." This table gives a detailed list of abbreviations, signs and symbols, used in every branch of science and which are, many times, very confusing even to the trained scientist, when found in the descriptive text of scientific articles without any explanatory note. The eleven pages are arranged alphabetically and can therefore be found quickly. Every student will welcome this information.

▼

MECHANICAL WORLD YEAR BOOK, 1932. Compiled and published by Emmott & Company, Ltd., 65 King St., Manchester, England; 361 pages; diagrams and tables; price 1s. 6d. net.—New features of this widely used power and mechanical engineering reference book include four new sections on metals and alloys, welding and cutting, tooth gearing and structural engineering.

RELATIVE HEAT TRANSFER THROUGH REFRACTORIES. By A. S. Watts and R. M. King. Published as Bulletin No. 64 of the Engineering Experiment Station, Ohio State University, Columbus, Ohio; 32 pages, illustrated; price 50c.—A summary of all investigations of this important subject, which have been undertaken at Ohio State University since 1922.

FRICTION OF SOME BABBITT ROLLER AND BALL BEARINGS. By E. R. Maurer and L. E. A. Kelso. Published as Bulletin No. 72 of the engineering Experiment Station, University of Wisconsin, Madison, Wis.; 48 pages, illustrated; price 50c.—Results of tests made since 1913 to determine the friction of some commercial line-shaft bearings under circumstances warranting comparisons of their frictional resistances.

THE BONBRIGHT SURVEY OF ELECTRIC POWER AND LIGHT COMPANIES OF THE UNITED STATES. Eighth Edition. Edited by G. F. Wittig and J. A. Stuart. Published by the McGraw-Hill Book Company, 330 West 42d St., New York City; 191 pages, charts and tables; price $10.—In the eighth edition of this annual public utility reference volume, the list of holding companies and subsidiaries has been thoroughly revised, and the financial data has been augmented to include more of the smaller properties and municipal plants.

WHAT'S NEW IN PLANT EQUIPMENT

Hydraulic Elevator Equipped With Push-Button Control

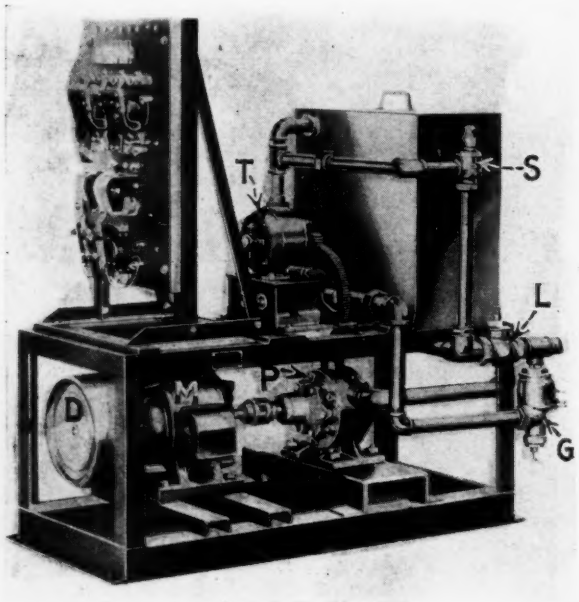
BEFORE the advent of high-speed electric elevators, the plunger-type hydraulic elevator was developed for high speeds and tall buildings because of their inherently safe, reliable, smooth operation, and ease of control. These, together with other features are incorporated in the new Hydromatic elevator, of the F. Rosenberg Elevator Company, Milwaukee, Wis. for use in two-story buildings and for sidewalk lifts. The control valves were designed to secure smooth and accurate control so that the equipment can be used for passenger service in residences and for freight service. A feature of the design is the elimination of penthouses and overhead supports.

All of the various units comprising the power plant of the elevator are assembled in a welded steel-frame to maintain alignment. The Hydromatic control valve, which is used to control the elevator in the down direction, is of the rotary disk type, operated by a torque motor; the opening and closing speeds are regulated by a spring-loaded hydraulic two-speed piston check. This valve is entirely metallic and packless, and due to the perfect control that can be obtained with it, speeds up to 100 ft. per min. and over can be obtained without hammer in the system.

In order to maintain the rated speed with all conditions of loading, a speed governor valve *G* is installed in the circuit ahead of the control valve. The use of this valve makes it possible to maintain a practically constant speed with a full-capacity load or an empty car.

The load-holding valve *L* holds the car or load at any point in the hoistway the instant the pump is stopped. The overload safety valve *S* is set for a pressure approximately 10 per cent higher than is required to lift the maximum load. In the event the car is overloaded, the oil is by-passed through this safety valve and back into the reservoir. This eliminates the annoyance of blowing fuses unnecessarily and damaging the equipment. The special-wound motor *M* together with a torque-dampening flywheel *D* produces good acceleration using a simple across-the-line magnetic starter. The torque-dampening flywheel is proportioned to the weight of each specific car size and rated capacity.

Accurate levelling is obtained without jar in the car. The ball bearing herring-bone gear pump *P* produces the required pressures without noise, and maintains within 5 per cent a constant delivery under the required range of pressures and is an important element in the performance of the elevator.



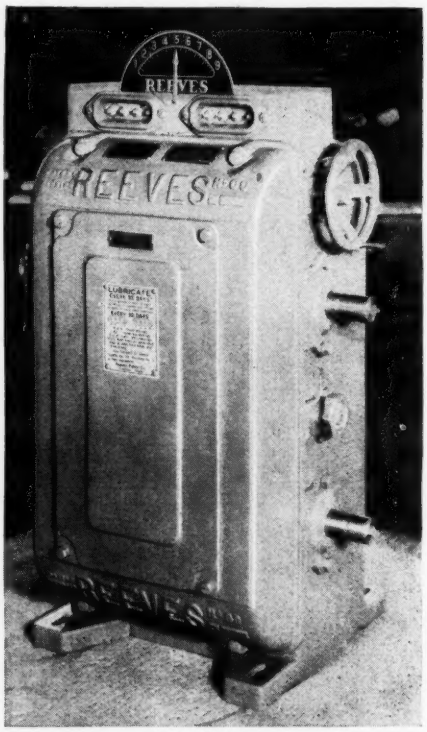
Motor pump and control of the Rosenberg "Hydromatic" elevator

Because the control can be obtained with push buttons, underwriters' approved fire doors with approved interlocks can be installed at the landing without inconvenience to the operators of the elevator. Wherever fire doors are not required, approved safety gates can be installed at the landing, equipped with the electric-mechanical interlocks which lock the gate for safe operation.

The sidewalk lift employs the same general features but, in addition, waterproof limit switches and control buttons are used to prevent short circuits and grounds in moist hoistways. The telescoping guides permit the car to travel above the sidewalk to a convenient truck level.

Vertical Inclosed-Design Transmission

COMPLETING the line of Reeves inclosed-design variable-speed transmissions, Reeves Pulley Company, Columbus, Ind., announces the new vertical enclosed design.



Reeves inclosed-design vertical transmission

This new unit, incorporating the standard internal operating parts of the Reeves transmission, is particularly adapted to certain standard equipment installations, and to installations requiring less floor space for the speed-control unit.

A dustproof, oiltight cast-iron case completely incloses all operating parts. All radial, shaft and thrust bearings are lubricated through force-feed fittings located in two convenient exterior panels. Shafts, driving keys and disk hubs are lubricated by force-feed fittings in each end of the shaft extensions.

The vertical unit may be equipped with electric-remote, electric automatic and mechanical automatic controls, and with motors, motor bases and other accessories for varying requirements of speed control.

Motor rails are so mounted that the lid of the cover section is accessible for removal. Cross rails, on which the motor is mounted, are also slotted for adjustment, and accommodate any design

or type of motor of the proper horsepower requirement consistent with the size of the transmission used. The motor base is adjustable vertically in order that any stretch in chain or multiple V-belt drive may be taken up. The motor may also be adjusted for alignment on the rails of the motor base. For extreme reduction in speeds, an auxiliary countershaft may also be installed.

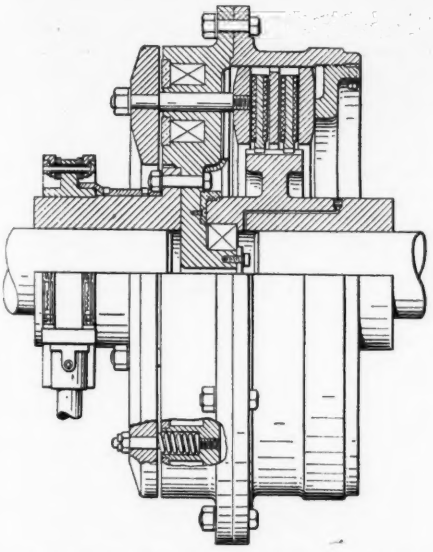
This design is available in ten sizes, covering speed ratios of from 2:1 to 8:1, inclusive.

High-Duty Multiple-Disk Magnetic Clutch

CONSISTING of only two elements, an electric magnet and friction device, the Stearns magnetic clutch is available in two, four and six-disk types, with capacities ranging from 3,700 to 60,900 lb.-ft. maximum torque.

As will be apparent from the illustration, the air gap between the armature and magnet body is visible at all times. This is normally set at 0.040 in. when the clutch is engaged. Instant disengagement is said to be positive owing to the armature's not being permitted to touch the magnet face. The friction linings are carried on both sides of the driven rings and the linings and friction rings are split to facilitate replacement.

It is pointed out by the manufacturer that as the forces required to operate



Partial cross-section of Stearns clutch

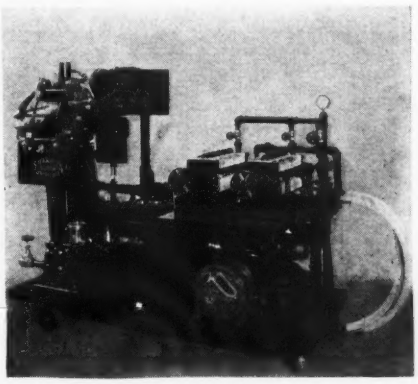
the clutch are balanced within the driving member, no end thrust is transmitted to the shaft during the engagement or disengagement of the clutch. Also, as the armature and magnet are contained in the driving member there is no relative rotation between them, thus the danger of scoring the magnet faces when the linings become worn is eliminated. Other features of the clutch, which is put out by the Magnetic Manufacturing Company, 201 W. 23d Ave., Milwaukee, Wis., will be apparent from the illustration.

Centrifugal Oil Purifier

A NEW TYPE of centrifugal oil purifier for transformer and circuit breaker oil, in which the oil is centrifugally purified under a high vacuum, has been introduced by the Sharples Specialty Company, 23d & Westmoreland St., Philadelphia, Pa., under the name of "Deoxator."

This vacuum type machine is designed to not only remove any free air in the oil but to also remove 90 per cent of the oxygen in solution and any dissolved moisture. The removal of the oxygen in solution tends to reduce the formation of sludge through oxidation while the removal of dissolved moisture produces a dielectric that will last longer.

Among the claims made for this machine by the manufacturer are that it can be used effectively for filling and "drying out" new equipment, filling Inertaire type transformers to eliminate second blowing with nitrogen, centrifuging oil in transformers that are designed to prevent air contact and preventing the introduction of any air whatsoever into the transformer, purifying oil for oil filled cables, purifying oil in subway type transformers that are sealed up tight, producing a purified oil with less sludge forming tendencies and having a more persistent dielectric.



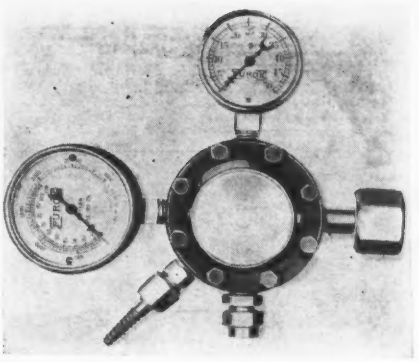
"Deoxator" oil purifier

In the "Deoxator" the centrifuge bowl is still used to remove free water and sludge while the vacuum removes dissolved moisture and oxygen.

Improved Oxygen and Acetylene Regulators

THE NEW Purox series of oxygen and acetylene regulators brought out by the Linde Air Products Company, 30 East 42nd Street, New York, N. Y., comprises six units, designated as Nos. 33 and 34 for acetylene; Nos. 13, 14, 23 and 24 for oxygen. All regulators are of all-metal construction, and the required volumes of oxygen and acetylene are delivered to the welding or cutting blowpipe at uniform pressure.

One of the outstanding design features of the new regulators is an accurate self-aligning valve of the nozzle and yoke type, giving sensitive action and freedom from leakage. Simplicity of construction also eliminates any need of disturbing the diaphragm, bonnet, pressure adjusting screw, or pressure adjusting spring when replacing a worn valve seat. Access to the interior of the regulator is gained by removing a plug in the rear of the body. A rupturing disk safety release on the oxygen regulator provides protection to the diaphragm should an abnormal pressure occur.



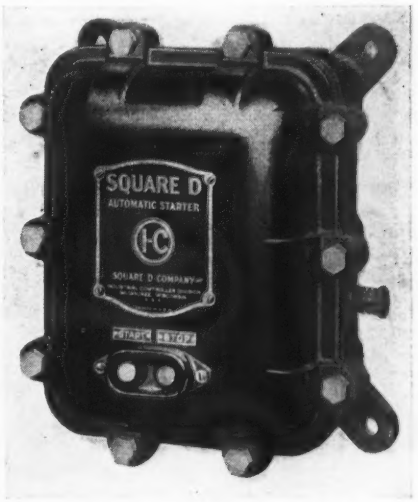
Purox No. 14 Oxygen welding regulator

Explosion-Proof Starters

TYPES AR-1 and BT-1 explosion-proof starters, introduced by the Square D Company, Milwaukee, Wis., are suitable for use in Class 1, Group D, locations, which include hazardous atmospheres.

Type AR-1, illustrated, has a "start-stop" push button in the cover, while Type BT-1 is designed for remote control. The starter mechanism consists of a ruggedly constructed three-pole magnetic contactor and thermal overload relays mounted on a porcelain base. An explosion-proof cast-iron inclosure surrounds the starter mechanism.

The starters provide low-voltage protection and release, also time-limit overload protection to alternating-current single and polyphase across-the-line motors.



Motor starter for use in explosive atmospheres

NEWS of the FIELD

Weld Tests Demonstrated at New York Meeting; Clements and Moore Discuss Fundamental Theory

SEVEN HUNDRED engineers gathered in New York on Feb. 18 to discuss fundamental problems relating to the testing of engineering materials, principally metals, and to witness dramatic demonstrations of ten different methods of testing welds. Held in the Engineering Societies Building, the meeting brought together local and national groups of the following societies: American Society for Testing Materials, American Institute of Mining and Metallurgical Engineers, American Welding Society and American Society of Steel Treaters.

Two addresses, preceding the demonstration, dealt with the philosophy of testing rather than with technical details. The two speakers were F. O. Clements, president of the A.S.T.M. and technical director of the General Motors Research Laboratories, and Prof. H. F. Moore, research professor of engineering materials at the University of Illinois. Both agreed that what we do not know is the most important knowledge.

There are 64 metallic elements, Mr. Clements pointed out, the number of possible alloys running into the billions. The field is so vast that progress by mere cut-and-try methods will leave undiscovered many practically important alloys. When we really understand the atom and the molecule, Mr. Clements said, we shall be in a position to "design" alloys at will to fit almost any required classification.

There would be a tremendous field, he pointed out, for alloys having a high ratio of strength to weight, for a metal with a higher modulus of elasticity than steel, for metals that would retain their strengths better at high temperatures, for very light metals with a high resistance to corrosion, for a successful corrosion resisting alloy of tantalum and iron, for a means of softening tungsten so that it could be machined and then hardened again. More fundamental knowledge will hasten such developments.

Professor Moore, widely known for his work in the field of materials testing, warned engineers that test results should not be accepted uncritically. A laboratory test, he said, is the engineer's attempt to crowd into ten minutes or a day the result of many years of actual service. The test result may or may not be a measure of serviceability.

Until the engineer knows from service experience the actual significance of any test method, he should use his results with caution. "In our modern world," says Professor Moore, "there has grown up what is almost a popular, superstitious reverence for test results obtained by the use of apparatus on which results may be repeated over and over when that apparatus is handled by skilled laboratory technicians."

In stressing specific tests, Professor Moore showed that such ductility measurements as elongation, reduction of area, and various bend tests, are not as closely related to service conditions as some imagine. Machine parts, for example, are rarely expected to yield to any such extent as test specimens. It is extremely difficult, he pointed out, to approximate service corrosion action in a short laboratory test. The simple word impact as applied to impact tests covers a mass of ignorance because nobody knows just how fast a load must be applied to become impact. He warned against judging the fatigue limit of a material from its elastic limit.

In conclusion Professor Moore said, "let every testing engineer keep alive his interest in and his study of the technique of testing and also of the service significance of the test results."

Following these addresses A. B. Kinzel and W. B. Miller of the Union Carbide & Carbon Research Laboratories, and John J. Crowe of the Air Reduction Company, used a portable testing machine and motion pictures to demonstrate ten standard tests for welds, four destructive and six non-destructive.

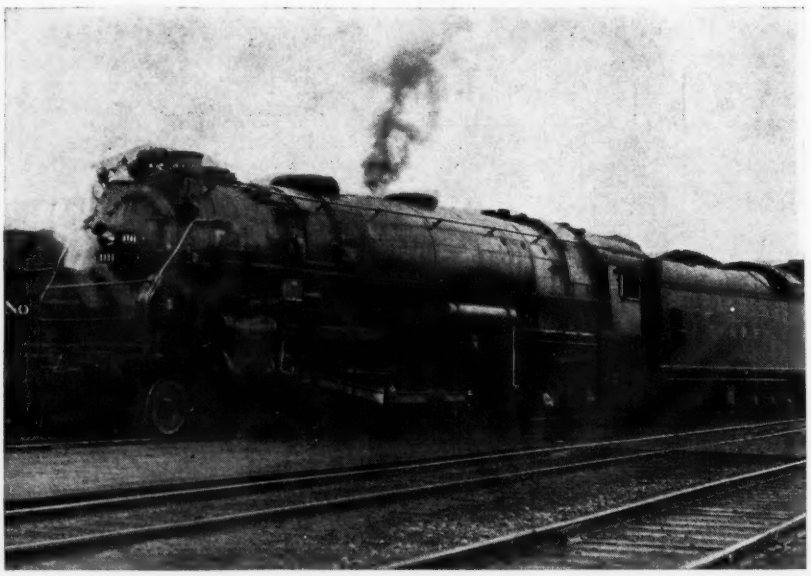
By visual examination alone, Mr. Crowe stated, a fairly reliable idea of weld quality can be obtained. The inspector can tell whether the operator is using the proper tip and flame size—whether he is melting down the parent metal. A fair idea of penetration can be obtained by inspecting the weld from the side of the bottom of the Vee.

Mr. Miller demonstrated the nick-break test. The specimen is nicked on two sides with a hacksaw blade and broken in a vise by the blow of a heavy hammer, after which the break is examined. This, he said, is a good rough-and-ready field test.

In the free-bend test, which he also demonstrated, the specimen is bent as a strut by a hydraulic jack, and the resulting elongation of the outer fibre

▼ ▼ ▼

AT THE END OF ITS 100,000-MILE TEST



Operating on fourteen different railroads from coast to coast since it was put in service in April, 1930, the first locomotive to be equipped with anti-friction bearings recently completed its initial test period of 100,000 miles. All axles of the locomotive and tender are fitted with Timken tapered roller bearings. During the entire test period under every condition of climate and railroad service, the locomotive performed with remarkable reliability, speed and maintenance economy

at the bend is measured. This test is easily made in the field.

Mr. Kinzel demonstrated a small field unit for tensile testing. Non-destructive tests exhibited included the Brinnell and the Rockwell for hardness, the specific gravity and the stethoscope test in which important defects are located by listening to the sound when the specimen is struck with a hammer.

The use of X-rays and Gamma-rays to reveal hidden defects was explained. Other field tests included the drift test in which the end of a welded tube is expanded by a cone and the crush test in which a short length of tube is collapsed like a bellows.

Utility Regulation Forum to Be Held in New York, Apr. 8-9

A MOVEMENT to provide "an adequate forum for the exchange and dissemination of views on regulatory principles and, practices" relating to public utilities was inaugurated in New York City, Feb. 21, according to announcement by Morris Llewellyn Cooke, trustee of the Power Authority of the State of New York.

The movement, it was stated, is sponsored by twelve of "the leading exponents of public regulation in the country," and a meeting is scheduled to be held here Apr. 8 and 9.

"The movement," said Mr. Cooke's statement, "was accelerated in part by the action of several members of the National Association of Railroad and Utilities Commissioners in declaring in a recent public statement their fear that 'regulation in the several states is being seriously imperiled by the conduct of the affairs' of the national association. In that statement they further stated that the association 'must change its course' or there was no alternative except withdrawal from membership."

The announcement said that letters have been sent to more than 100 persons inviting them to attend the meeting here.

Gatineau Power Company to Enlarge Ottawa Facilities

GATINEAU POWER COMPANY, a part of International Hydro-Electric System, has commenced the construction of additional substation and transmission line facilities in order to provide for expanding electric power requirements in the Ottawa and Hull districts. The capacity of the company's Val Tetreau substation for supplying 11,000-volt power is being increased from 40,000 to 80,000 hp. through the installation of three additional 10,000-kva. transformers of the outdoor switching type, and additional 110,000- and 11,000-volt switching equipment.

From the Val Tetreau substation an 11,000 volt steel tower line one and one-quarter miles long is being constructed to the Chaudiere district by the company for distribution of power from that point. This line will be designed to carry six three-phase 11,000 volt circuits, of which two new circuits will be installed at this time and three existing circuits will be moved over from the present wood pole line. Additional 11,000 volt switching will be installed at the Chaudiere No. 2 power house.

MEMORIAL TO THOMAS A. EDISON

Hugh A. Kelly and John B. Peterkin, Architects

Architect's sketch of the monument which friends, associates and admirers of the late Thomas A. Edison propose erecting to his memory at Menlo Park, N. J.

▼ ▼ ▼

"Power Engineers' Day" in Philadelphia, Pa., Apr. 2

SATURDAY, APR. 2, has been designated as "Power Engineers' Day" in Philadelphia, Pa. The local chapters of the National Association of Power Engineers and other engineering organizations will hold an all-day meeting on that date, which will include two technical sessions, luncheon, dinner, entertainment and dance. All events will take place at the Penn Athletic Club.

The program is being arranged by the following committee: Herbert A. Russell, superintendent of power at the University of Pennsylvania, chairman; Dr. R. L. Martin, vice-chairman; Joseph D. Chapline, secretary; Samuel Jones, assistant secretary; W. Elwood Schultz, treasurer; Clifford Evans; Edward Green; and Harry McKee.

N. Y. Bill Extends Scope of Interstate Power Commission

UNDER THE PROVISION of a bill introduced in the New York Senate recently Chapter 673 of the laws of 1931 is amended, relative to powers and duties of the state commission on survey of utility companies engaged in interstate transmission of power by adding gas to the items carried from state to state and adding the language:

"Such commission shall have like power to meet commissioners appointed, or who may be appointed, on behalf of the Dominion of Canada, or the provinces of Ontario and Quebec, to negotiate and agree upon the terms of like treaties and compacts for submission to the proper authorities of such dominion and provinces, to the Legislature of the State of New York, and to the Congress of the United States for approval. Should there be no commissions appointed on behalf of the states adjoining the State of New York, or of the said dominion or provinces, the commission established for the State of New York by this act shall have the above powers to negotiate and agree with the governors of such adjoining states or with the established utility commissions thereof when so directed by the governors of such states, and with the prime minister of such dominion and the premiers of such provinces, or such

established authorities as they may respectively designate."

Other bills recently introduced in the Senate would prohibit the use of locomotive steam power generated by burning bituminous coal in any city having a population of 1,000,000 or more (i.e. New York City), and would permit the use of electric contacts or interlocks of a type approved by the industrial board on "fire doors at each entrance to elevator or dumbwater hoistways."

Utility Aids Employees by Offering Land for Gardens

EL PASO ELECTRIC COMPANY officials have adopted a practical method for aiding employees in all departments through the depression. At the Rio Grande power station site the company has available about 35 acres of tillable land not being used. This land is being offered to employees in all departments of the company, in small blocks, to be used for planting gardens. The land in acre and half-acre tracts may be procured rent free by any company employee in the order in which it is applied for. Those taking advantage of this offer will be able to raise enough garden truck for use of their families without other cost than the expense connected with tilling the land and planting the crop.

Various company employees are displaying keen interest in possibilities of the plan and already a number of them have signified an intention to file for some of the land.

Lamme Medal to G. Faccioli, Noted Transmission Engineer

THE 1931 LAMME MEDAL of the American Institute of Electrical Engineers has been awarded to Giuseppe Faccioli, Pittsfield, Mass., "for his contributions to the development and standardization of high-voltage oil-filled bushings, capacitors, lightning arresters, and numerous features in high voltage transformers and power transmission," and will be presented at the summer convention of the Institute which is to be held in Cleveland, Ohio, June 20 to 24.

Mr. Faccioli, who retired on May 27, 1930, from his active duties as works engineer and associate manager of the Pittsfield Works of the General Electric Company and became a consulting engineer for the company, was born in Rome, Italy, in 1877, and was graduated with high honors from the Institute of Technology, Milan, Italy, as an electrical and mechanical engineer, in 1899.

His early American experience was secured in the New York Edison, Interborough Rapid Transit, and Crocker-Wheeler Companies. His work soon attracted the attention of the late William Stanley who induced Mr. Faccioli to become his principal assistant in his laboratories in Great Barrington, Mass. When the Stanley laboratories were absorbed by the General Electric Company in 1906, Mr. Faccioli was given broader duties in the engineering department of the Pittsfield works. He was appointed assistant chief engineer of the transformer department in 1911, and works engineer three years later.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meetings at Milwaukee, Wis., March 14-16, and Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Boiler Manufacturers Association. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockfeller Building, Cleveland, Ohio.

American Society for Testing Materials. Committees group meetings in Cleveland, Ohio, March 7-11. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, Joan F. Kelly, Empire Building, Pittsburgh.

Fifth Annual Midwest Bituminous Coal Conference. At Purdue University, Lafeyette, Ind., Apr. 14-15. Secretary, W. A. Knapp, Engineering Experiment Station, Purdue University, Lafayette, Ind.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metropolitan Section. Power Division meeting in Room 501, Engineering Societies Building, March 22 at 8 p.m. Subject: "Some Notes on the Performance of Boiler Furnaces," A. T. Brown.

N.A.P.E., Philadelphia Locals. All-day meeting in conjunction with other engineering organizations, to be known as "Power Engineers' Day," at the Penn Athletic Club, Apr. 2. Technical sessions and entertainment.

A.I.E.E., Providence Chapter. Meeting in the Society Rooms, March 8 at 8 p.m. Subject: "Vertical Transportation," A. S. Noyes.

1931 Coal Output 19% Under Previous Year, Bureau Reports

IN ORDER TO OBTAIN a conception of the statistical services performed by the Bureau of Mines, the House Appropriations Committee during its consideration of the Commerce Department appropriation bill, requested a report regarding the coal situation in this country. The report was presented by Scott Turner, director of the Bureau of Mines. He informed the committee that preliminary estimates for 1931 indicate a production of but 378,110,000 net tons of bituminous coal, a decline of 19 per cent from the previous year and about 30 per cent from the figures of 1929.

Since a large part of the anthracite production is used for domestic heating, Mr. Turner pointed out that this type of coal is less affected by a general decline in business. The estimated production of anthracite in 1931 is 59,531,000 net tons. This is a decline of 14 per cent from the previous year and about 19.5 per cent under 1929. In explaining the general decline in coal consumption, Mr. Turner mentioned the following cases:

For the first ten months of 1931 class 1 railroads decreased their consumption of coal by 16 per cent. For the same period, the electric public utilities declined 8.6 per cent in their consumption while the amount used for foreign bunkers dropped 36.4 per cent. In foreign trade, exports of coal declined 24 per cent during the first ten months of 1931. Imports of anthracite from Russia increased from approximately 170,000 tons in 1930 to around 200,000 tons in 1931. On the other hand, anthracite from the United Kingdom decreased from about 400,000 tons in 1930 to approximately 300,000 tons in 1931. The average cost of bituminous coal per net ton f.o.b. mines, was 12.4 per cent lower in November, 1931, than in November of 1930.

New Hydro Installation For Grand Forks, B. C.

INSTALLATION of a power plant at Grand Forks, B. C., using two twin power units of 150 hp. each, capable of developing 460 hp. with the lowest flow of water, would cost approximately $40,000, according to information received at the first regular meeting of the City Council for the new year. Before the matter is referred to the property owners for endorsement, it will be given further consideration by the council.

In the meantime, work on reconstructing the power dam at Grand Forks has been ordered commenced as necessary whether the new power plant is proceeded with or not. The reconstruction work will involve the building of new gates which will permit of installing the proposed plant without hindrance from high water.

Personals

FRANK W. SMITH, who was recently elected president of the New York Edison Company to succeed MATTHEW S. SLOAN, resigned, has been elected also president of the United Electric Light & Power Company. ARTHUR H. KEHOE, electrical engineer of the United company, and RALPH H. TAPSCOTT electrical engineer of the Edison company, have been elected vice-presidents of both organizations.

M. WILLIAM EHRLICH, formerly New York manager of the Trane Company, LaCrosse, Wis., is now chief engineer of the Commodore Heaters Corporation, New York City.

C. J. FECHHEIMER, previously of the power engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has opened his own consulting engineering offices in the Title Guaranty Building, Milwaukee, Wis. Those interested in the development of electrical machinery will recall Mr. Fechheimer as the author of technical literature on this subject. At present he is extending his work in this field by giving a course of lectures on thermal problems in electrical machinery under the auspices of the Milwaukee Extension Division of the University of Wisconsin.

J. M. GAYLORD, formerly chief electrical engineer of the United States Bureau of Reclamation, and more recently superintendent of hydro generation for the Southern California Edison Company, at Pasadena, Calif., has been appointed chief electrical engineer of the Metropolitan Water District of Southern California.

LANE THOMPSON, manager of the Pittsburgh office of the Lunkenheimer Company, Cincinnati, Ohio, died on Feb. 7. Mr. Thompson had been closely identified with the sales work of the company for many years.

C. A. LELAND, JR., vice-president and general manager of the Des Moines Electric Light Company and the Des Moines Gas Company, will take charge of the Kansas utility properties of the North American Light & Power Company, succeeding the late ALBERT PATTEN of Topeka. Mr. Leland will retain supervision of the Iowa holdings of the company and will handle the duties of his Kansas position from Des Moines.

ROY PAGE, vice-president and general manager of the Nebraska Power Company, Omaha, has been elected vice-president of the Citizens' Power & Light Company, Council Bluffs, Ia. Mr. Page joined the Nebraska company in 1917 as assistant to the vice-president.

HAROLD W. BIBBER left the central-station engineering department of the General Electric Company recently to become associate professor of electrical engineering at Ohio State University.

How's Business?

THE LEVEL of industrial and commercial activity is still slowly subsiding, but a belated and possibly brisk Spring spurt is still expected as soon as the effect of the Administration's financial measures is felt and low-price automobile production gets under way. Steel and electric power output (1,545,459,000 kw.-hr. for the week ended Feb. 20, according to the N.E.L.A.) are still persistently depressed by delayed automotive demand, problematic price policies and unseasonable weather. A mild revival of rail demand and strengthening in second-quarter steel quotations are slightly encouraging indications that some seasonal increase in steel activity will not be lacking, though unusually late. Building contract figures for the first half of February are more hopeful than was expected.—*The Business Week*, March 2.

Business Notes

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwauke, Wis., announces the appointment of L. W. Grothaus as general representative to succeed Clarence E. Searle, who has just resigned to accept the vice-presidency of an Eastern firm. Mr. Grothaus has been assistant manager of the electrical department of the company.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., has appointed H. C. Thomas assistant to the general works manager. Mr. Thomas is being advanced from the position of director of manufacturing stocks, which he has held since September, 1929.

POWER EQUIPMENT COMPANY is the new name of the Steam Equipment Company, sales agents of Memphis, Tenn. This change in name, effective Feb. 1, was made necessary by the broadening of its field to include diesel engines, pumps, compressors and electrical apparatus in addition to the original line of steam equipment, the firm states.

MERCON REGULATOR COMPANY, Chicago, Ill., announces the appointment of R. E. Chase & Company, Tacoma, Wash., as its representative for the states of Washington, Oregon and Idaho.

BLAW-KNOX COMPANY, Pittsburgh, Pa., announces the appointment of M. I. Dorfan as manager of its new dust collector division. Mr. Dorfan was formerly manager of the dust collector division of the Pangborn Corporation, and prior to that he was in charge of dust collector sales for the Allis-Chalmers Manufacturing Company.

READING-PRATT & CADY COMPANY, Bridgeport, Conn., has appointed James P. Ferguson assistant general manager of sales. Mr. Ferguson has been associated with the company for the past ten years as sales engineer.

ALLEN - SHERMAN - HOFF COMPANY, Philadelphia, Pa., announces the appointment of the Kent Ervin Engineering Company, Builders Exchange Building, Minneapolis, Minn., as representatives for the sale of its products in Minnesota, North Dakota, South Dakota and northwestern Wisconsin.

Trade Catalogs

REFRACTORIES—Bulletin 1-13-15, entitled "Improved Lavino Chrome Brick (new process) vs. the Best Chrome Brick (usual process)," has just been issued by E. J. Lavino & Company, Bullitt Building, Philadelphia, Pa. It contains the results of spalling, hot-load and sagging tests made on the two kinds of bricks.

DIESEL ENGINES — An illustrated description of the Cummins automotive diesel engine is contained in a folder recently issued by the Cummins Engine Company, Columbus, Ind. Specifications of the engine are briefly covered, together with the results of several speed and endurance tests it has undergone.

GAS PRODUCER — The Semet-Solvay Engineering Corporation, 40 Rector St., New York, N. Y., has just issued Bulletin No. 45, which fully describes and illustrates the company's Koller Type gas producer.

STARTING SWITCHES—Full details of operation, construction and application of high-tension across-the-line starting switches are given in illustrated Bulletin 726, recently published by the Allen-Bradley Company, Milwaukee, Wis.

PIPE FITTINGS—Up-to-date tabulated data on the dimensions and prices of Taylor forge fittings and seamless steel pipe fittings for welding are contained in Bulletin 32-1, just issued by the Taylor Forge & Pipe Works, P. O. 485, Chicago, Ill.

GAS PUMPS—Bulletin 31-B10, recently released by Roots-Connersville-Wilbraham, division of the International-Stacey Corporation, Connersville, Ind., describes and illustrates the Victor-Acme gas pumps. Tables of specifications and prices are included.

ALLOY STEEL—The properties and advantages of chrome-vanadium nitriding steel are briefly described in a new illustrated technical bulletin (No. CV 1) published by the Electro Metallurgical Company, 30 East 42nd St., New York.

NEW PLANT CONSTRUCTION

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Fayetteville—City voted $65,000 bond issue to finance purchase of a tract of land to be used as the site for United States Veterans' Hospital. The hospital group will consist of eleven buildings, including 125 x 275 ft. main building, 50 x 150 ft. administration building, 100 x 150 ft. nurses' home, boiler house, etc. $1,000,000.

Ark., Hot Springs — Army & Navy General Hospital, Capt. E. M. George, Constructing Quartermaster, awarded contract for construction of a hospital here to National Construction Co., Washington, D. C. Estimated total cost $1,500,000.

Conn., Hartford — Highland Ice Co., 319 Sigourney St., having plans prepared for construction of a 1 story, 50 x 125 ft. ice manufacturing plant, 50 ton daily capacity on Wethersfield Ave. Estimated cost $75,000. Raymond E. Palmer, 56 Suffolk St., Holyoke, Mass., is engineer. Contract for equipment awarded to York Ice Machinery Co., 2nd Ave. and 42nd St., Brooklyn, N. Y.

Conn., Meriden—Southern New England Ice Co., Ralph G. Hadley, Gen. Mgr., Corbin Pl., New Britain, having plans prepared for construction of an artificial ice plant here. Estimated cost $40,000. Private plans.

Conn., Willimantic—Brown Brothers & Co., Ash St., plans construction of ice manufacturing plant. Estimated cost $40,000. Private plans.

Ill., Freeport—Park Commission, C. Demiter, Pres., plans park improvements including artesian well, power water pumps, etc. Estimated cost $50,000. A. F. Stanley, City Hall, is engineer.

Ill., Lake Forest—City, c/o J. C. McNicol, Supt. of Water Department, City Hall, plans addition to waterworks pumping and filtration plant at Spruce St. and Lake Michigan. Estimated cost $50,000. Private plans. Maturity late spring or early summer.

Ill., Lake Zurich—City completed plans for construction of a sewage pumping station including complete pumping equipment and necessary appurtenances. James Anderson, 228 East Deerpath Road, Lake Forest, is engineer. Indefinite when bids will be taken. Awaiting court confirmation.

Ill., Stickney—Sanitary District, 910 South Michigan Ave., Chicago, will soon award contract for improvements to sewage treatment plant including vacuum filter with vacuum and sludge pumps, rotary driven conveyors, coal and ash handling equipment, etc., at 52nd Ave. and Bushing Road here.

Ia., Morengo—City plans election in March to vote $125,000 bonds for construction of municipal power plant. Engineer not selected.

Mass., Holyoke—Holyoke Ice Co., W. T. Wilson, Pres., 65 Prospect St., awarded contract for construction of a 1 story, 60 x 120 ft. artificial ice plant at Walnut and Prospect Sts. to Casper-Ranger Construction Co., 20 Bond St. Estimated cost $40,000.

Mass., North Leominster—Harris Ice Co., Inc., Day St., receiving bids for construction of a 2 story ice manufacturing plant on Main St. Estimated cost $50,000. Private plans.

Mass., Worcester—Tatnuck Ice Co., Brookside Ave., awarded contract for a 1 story, 65 x 105 ft. ice manufacturing plant on Mill St., to E. D. Ward Co., 82 Foster St. Estimated cost $40,000.

N. Y., Rodman — New York Utilities Inc., Watertown, has been granted permit by Public Service Commission to construct electric power plant extensions here.

N. Y., Yonkers—Alexander Smith & Son, Elm and Palisade Aves., awarded contract for construction of a 1 story, 44 x 69 ft. addition to power plant to Barney Ahlers Construction Co., 110 West 40th St., New York.

Ohio—Ohio Edison Co., c/o A. L. Richman, Ohio Edison Bldg., Akron, awarded general contract for construction of two electric sub-stations, one at Fairlawn near Akron and one at Medina, to Allied Engineers Inc., 162 Carroll St., Akron. Estimated total cost $90,000.

O., Cleveland—Cleveland Railway Co., George D. McGwinn, Pres., 600 Midland Bldg., plans construction of three power converting stations. Estimated cost $170,000. L. P. Bale, Midland Bldg., is architect and engineer.

O., Dayton—Department of Public Welfare, Ninth and Oak Sts., John McSweeney, Dir., Columbus, will soon receive bids for construction of an ice plant, 20 ton capacity, including creamery equipment at Dayton State Hospital here.

Ore., Roseberg—Construction Service, Veterans' Administration, Washington, D. C., will receive bids until March 22 for construction and finishing complete buildings and utilities, including refrigeration and ice-making plant, boiler plant equipment, heating and ventilating systems, etc., at Veterans' Administration Home here.

Pa., Ambridge—Borough of Ambridge, A. W. Johns, Mgr., will soon receive bids for construction of 14 x 20 ft. booster water pumping station. Private plans. Pumps to be purchased separately.

Pa., Huntingdon — Pennsylvania Industrial School, having plans prepared for construction of central building, cottage group and boiler house. Estimated total cost $325,000. Russell G. Howard, Dependent National Bank Bldg., DuBois, is architect.

Va., Amherst—Board of Supervisors, Amherst County, plans an election March 23 to vote $60,000 for construction of water system including combined filtration and pumping plant, distribution system, etc., at Madison Heights. E. E. Barnard, Law Bldg., Lynchburg, is consulting engineer.

Wash., Ellensburg—Bureau of Reclamation, will receive bids until March 30 for construction of Wippel pumping plant and appurtenant structures, etc. Kittitas Division, Yakima project. F. W. Dent, Acting Comr.

Wash., Osier—Puget Sound Power & Light Co., Stuart Bldg., Seattle, plans to expend $25,000 for extensions and improvements in Marysville District including sub-station which will raise voltage from 4,000 to 12,000 out of Everett. The sub-station will include transformers and voltage regulators, also plans line from Snohomish South to connect with Cathcart system.

Wis., Milwaukee—Metropolitan Sewage Commission, awarded contracts for sub-structure and superstructure of sewage booster station at Port Washington St. to Klug & Smith, 111 East Wisconsin Ave., $18,650, and L. F. Schroeder Construction Co., Fond du Lac, $12,950.

Equipment Wanted

Air Compressors—Dayton, O.—Contracting Officer, Material Division, Air Corps, Wright Field, will receive bids until March 8 for three air compressors, complete with air receiver, motor and after cooler. Cir. 295.

Boiler, Pumps, Water Heater, Etc, Greensburg, Pa.—County Home, c/o Garfield A. McDowell, Comptroller, will receive bids until March 11 for furnishing and installing 150 hp. boiler, vacuum and boiler water pumps, hot water heater, etc.

Generator Set, Panel, Transformers, etc.—Washington, D. C.—General Purchasing Officer of Panama Canal, will receive bids until March 10 for electric motors, motor generato set, panel boards, transformers, switches, electric water heaters, etc. Sch. 2732.

Generators—Pennsylvania and Virginia—Bureau of Supplies & Accounts, Navy Department, Washington, D. C., will receive bids until March 8 for nine motor generators and nine panels and spares for Navy Yards at Philadelphia and Norfolk. Sch. 7503.

Pump—Indianapolis, Ind.—Sanitary Commissioners, Room 103, City Hall, will receive bids until March 8 for furnishing and installing centrifugal pump.

Pump—Chaska, Minn.—City plans to purchase a 300 to 500 g.p.m. deep well turbine pump.

Pump—Billings, Mont.—City plans furnishing and installing 5,000,000 gal. pump for waterworks filtration plant.

Pump—Huron, S. D.—City will receive bids until March 14 for furnishing and installing pump, electric motor, etc., in connection with proposed waterworks improvements.

Pumps—Cincinnati, O.—City, c/o Charles E. Lex Jr., Room 143, City Hall, Purch. Agt., will receive bids until March 9 for two steam turbine driven centrifugal pumps and appurtenances, one for main pumping station at 2545 Eastern Ave., and one for Western Hills Station, Queen City Ave.

Industrial Projects

Calif., San Francisco — Electrical Products Corp., 950 30th St., Oakland, plans construction of a factory and office building at 12th and Market Sts. here. Estimated cost to exceed $40,000. Private plans.

Ga., Lindale — Pepperell Mfg. Co., H. P. Meikleham, Agt., plans installation of electric power equipment in connection with new cotton mill. Estimated total cost $300,000.

Ill., Chicago—Cromwell Paper Co., 4801 South Whipple St., awarded contract for a 1 story, 89 x 215 ft. addition to factory at 47th and Whipple Sts., to E. W. Sproule Construction Co., 2001 Pershing Road. Estimated cost $50,000.

Ill., Streator—Streator Clay Manufacturing Co., plans to rebuild sewer pipe factory, 4 story, 110 x 200 ft. destroyed by fire. Estimated cost $250,000. Engineer not selected. Maturity 1933.

La., New Orleans—Horman-Salmen Co. Inc., 3901 South Carrollton St., having plans prepared for a 1 story, 60 x 200 ft. ink plant on South Jefferson Davis Parkway. Estimated cost $50,000. Rathbone De Buys, Hibernia Bldg., is architect.

Mass., Taunton—Brownell & Burk Co., Washington St., manufacturers of carriage and automobile bodies, plans to rebuild factory at Washington St. and Hodges Ave. recently destroyed by fire. Estimated cost $60,000. Private plans.

Mass., Worcester—Reed & Prince Manufacturing Co., will build a power plant near Cambridge St. Estimated cost $100,000. Work will be done by separate contracts under the supervision of E. F. Sill, East Main St., Westboro, Engr.

N. J., Newark—Hoyt Bros. Inc., 100 Shipman St., receiving bids for construction of a 7 story, 55 x 80 ft. chemical manufacturing plant. Estimated cost $150,000. H. C. Hammel, Inc., 130 Branford Pl., are architects and engineers.

N. J., Rahway—Merck & Co. Inc., Lincoln Ave., receiving bids for a 1 and 2 story addition to chemical manufacturing plant. Estimated cost $150,000. C. B. Lewellyn, c/o owner, is architect and engineer.

Pa., Edgley—Owner, c/o Hannichen Engineering Co., 222 West Broadway, Paterson, N. J., Archt. and Engr., having preliminary plans prepared for a 2 story, 90 x 200 ft. addition to paper plant at State Rd. and Delaware River here. Estimated cost $40,000.

Que., Quebec City—Canac-Marquis Glue Co., plans construction of a factory at Ste. Marie d'l Incarnation St. Estimated cost $125,000. Will be required.

Que., Rougemont—Model Table Co., Napoleon Giard, plans construction of a factory. Estimated cost $40,000. Machinery will be required.